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THE RACES OF MANKIND.*

By E. B. TYLOR, F. R. S.

ANTHROPOLOGY finds race-differences most clearly in stature and proportions of limbs, conformation of the skull and the brain within, characters of features, skin, eyes, and hair, peculiarities of constitution, and mental and moral temperament.

In comparing races as to their stature, we concern ourselves not with the tallest or shortest men of each tribe, but with the ordinary or average-sized men who may be taken as fair representatives of their whole tribe. The difference of general stature is well shown where a tall and a short people come together in one district. Thus, in Australia the average English colonist of five feet eight inches looks clear over the heads of the five feet four inch Chinese laborers. Still more in Sweden does the Swede of five feet seven inches tower over the stunted Lapps, whose average measure is not much over five feet. Among the tallest of mankind are the Patagonians, who seemed a race of giants to the Europeans who first watched them striding along their cliffs draped in their skin cloaks; it was even declared that the heads of Magalhaens's men hardly reached the waist of the first Patagonian they met. Modern travelers find, on measuring them, that they really often reach six feet four inches, their mean height being about five feet eleven inches—three or four inches taller than average Englishmen. The shortest of mankind are the Bushmen and related tribes in South Africa, with an average height not far exceeding four feet six inches. A fair contrast between the tallest and shortest races of mankind may be seen in Fig. 1, where a Patagonian is drawn side by side with a

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Bushman, whose head only reaches to his breast. Thus, the tallest race of man is less than one fourth higher than the shortest, a fact which seems surprising to those not used to measurements. In general, the stature of the women of any race may be taken as about one sixteenth less than that of the men. Thus, in England a man of five feet eight inches and a woman of five feet four inches look an ordinary well-matched conple.

Not only the stature, but the proportions of the body, differ in men of various races. Care must be taken not to confuse real race-differ-

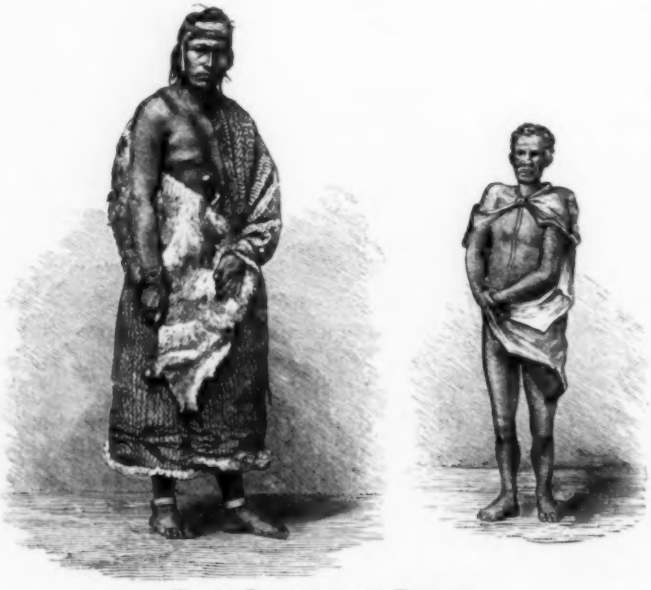


FIG. 1.—PATAGONIAN AND BUSHMAN.

ences with the alterations made by the individual's early training or habit of life. A man's measure round the chest depends a good deal on his way of life, as do also the lengths of arm and leg, which are not even the same in soldiers and sailors. But there are certain distinctions which are inherited, and mark different races. Thus, there are long-limbed and short-limbed tribes of mankind. The African negro is remarkable for length of arm and leg, the Aymara Indian of Peru for shortness. Negro soldiers standing at drill bring the middle finger-tip an inch or two nearer the knee than white men can do, and some have been even known to touch the knee-pan. Such differences, however, are less remarkable than the general correspondence in bodily proportions of a model of strength and beauty, to whatever race he may belong. Even good judges have been led to forget the niceties of race-type and to treat the form of the athlete as everywhere one and the same. Thus, Benjamin West, the American painter, when he

came to Rome and saw the Belvedere Apollo, exclaimed, "It is a young Mohawk warrior!" Much the same has been said of the proportions of Zooloo athletes. Yet, if fairly-chosen photographs of Caffres be compared with a classic model, such as the Apollo, it will be noticed that the trunk of the African has a somewhat wall-sided straightness, wanting in the inward slope which gives fineness to the waist, and in the expansion below which gives breadth across the hips, these being two of the most noticeable points in the classic model which our painters recognize as an ideal of manly beauty.

In comparing races, one of the first questions that occurs is, whether people, who differ so much intellectually as savage tribes and civilized nations, show any corresponding difference in their brain. There is, in fact, a considerable difference. The most usual way of ascertaining the quantity of brain is to measure the capacity of the brain-case by filling skulls with shot or seed. Professor Flower gives as a mean estimate of the contents of skulls in cubic inches—Australian, seventy-nine; African, eighty-five; European, ninety-one. Eminent anatomists also think that the brain of the European is somewhat more complex in its convolutions than the brain of a negro or Hottentot. Thus, though these observations are far from perfect, they show a connection between a more full and intricate system of brain-cells and fibers, and a higher intellectual power, in the races which have risen in the scale of civilization.

The form of the skull itself has been to the anatomist one of the best means of distinguishing races. It is often possible to tell by inspection of a skull what race it belongs to. In comparing skulls, some of the most easily noticeable distinctions are the following:

When looked at from the vertical or top view, the proportion of breadth to length is seen as in Fig. 2. Taking the diameter from back

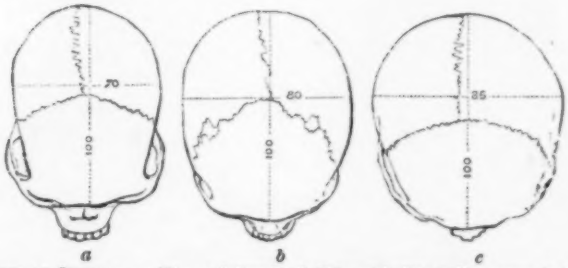


FIG. 2.—TOP VIEW OF SKULLS. *a*, Negro, index 70, dolichocephalic; *b*, European, index 80, mesocephalic; *c*, Samoyed, index 85, brachycephalic.

to front as 100, the cross diameter gives the so-called index of breadth, which is here about 70 in the negro (*a*), 80 in the European (*b*), and 85 in the Samoyed (*c*). Such skulls are classed respectively as *dolichocephalic*, or "long-headed"; *mesocephalic*, or "middle-headed"; and *brachycephalic*, or "short-headed." A model skull of a flexible

material like gutta-percha, if of the middle shape, like that of an ordinary Englishman, might, by pressure at the sides, be made long like a negro's, or by pressure at back and front be brought to the broad Tartar form. In the above figure it may be noticed that while some

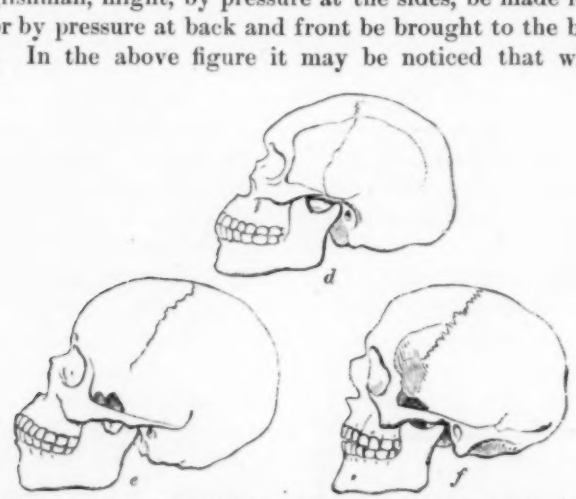


FIG. 3.—SIDE VIEW OF SKULLS. *d*, Australian, prognathous; *e*, African, prognathous; *f*, European, orthognathous.

skulls, as *b*, have a somewhat elliptical form, others, as *a*, are ovoid, having the longest cross diameter considerably behind the center. Also in some classes of skulls, as in *a*, the zygomatic arches connecting the skull and face are fully seen; while in others, as *b* and *c*, the bulging of the skull almost hides them. In the front and back view of skulls, the proportion of width to height is taken in much the same

FIG. 4.—*a*, Swaheli; *b*, Persian.

way as the index of breadth just described. Next Fig. 3, which represents in profile the skulls of an Australian (*d*), a negro (*e*), and an Englishman (*f*), shows the strong difference in the facial angle between the two lower races and our own. The Australian and African

are *prognathous*, or "forward-jawed," while the European is *orthognathous*, or "upright-jawed." At the same time the Australian and African have more retreating foreheads than the European, to the disadvantage of the frontal lobes of their brain as compared with ours.

FIG. 5.—FEMALE PORTRAITS. *a*, Negro (W. Africa); *b*, Barolong (S. Africa); *c*, Hottentot; *d*, Gilyak (N. Asia); *e*, Japanese; *f*, Colorado Indian (N. America); *g*, English.

Thus the upper and lower parts of the profile combine to give the faces of these less civilized peoples a somewhat ape-like slope, as distinguished from the more nearly upright European face.

Let us now glance at the evident points of the living face. To some extent feature directly follows the shape of the skull beneath. Thus the contrast just mentioned, between the forward-sloping negro skull and its more upright form in the white race, is as plainly seen in the portraits of a Swaheli negro and a Persian, given in Fig. 4. On looking at the female portraits in Fig. 5, the Barolong girl (South Africa) may be selected as an example of the effect of narrowness of skull (*b*), in contrast with the broader Tartar and North American faces (*d*, *f*). She also shows the convex African forehead, while they, as well as the Hottentot (*c*), show the effect of high cheek-bones. The Tartar and Japanese faces (*d*, *e*) show the skew-eyelids of the Mongolian race. Much of the character of the human face depends on the shape of the softer parts—nose, lips, cheeks, chin, etc.—which are often excellent marks to distinguish race. Contrasts in the form of nose may even exceed that here shown between the aquiline of the Persian and the snub of the negro in Figs. 4 and 6. European travelers in Tartary in the middle ages described its flat-nosed inhabitants as having no noses at all, but breathing through holes in their faces. By pushing the tips of our own noses upward, we can in some degree imitate the manner in which various other races, notably the negro, show the opening of the nostrils in full face. Our thin, close-fitting lips differ in the extreme from those of the negro, well seen in the portrait

FIG. 6.—AFRICAN NEGRO.

(Fig. 6) of Jacob Wainwright, Livingstone's faithful boy. With the purpose of calling attention to some well-marked peculiarities of the human face in different races, a small group of female faces (Fig. 5) is given, all young, and such as would be considered among their own

people as at least moderately handsome. Setting aside hair and complexion, there is still enough difference in the actual outline of the features to distinguish the negro, Caffre, Hottentot, Tartar, Japanese, and North American faces from the English face below.

The color of the skin, that important mark of race, may be best understood by looking at the darkest variety. The dark hue of the negro does not lie so deep as the innermost or true skin, which is substantially alike among all races of mankind. The negro, in spite of his name, is not black, but deep brown, and even this darkest hue does not appear at the beginning of life, for the new-born negro child is reddish-brown, soon becoming slaty-gray, and then darkening. Nor does the darkest tint ever extend over the negro's whole body, but his soles and palms are brown. The coloring of the dark races appears to be similar in nature to the temporary freckling and sunburning of the fair white race. On the whole, it seems that the distinction of color, from the fairest Englishman to the darkest African, has no hard and fast lines, but varies gradually from one tint to another.

The natural hue of skin farthest from that of the negro is the complexion of the fair race of Northern Europe, of which perfect types are to be met with in Scandinavia, North Germany, and England. In such fair or blonde people the almost transparent skin has its pink tinge by showing the small blood-vessels through it. In the nations of Southern Europe, such as Italians and Spaniards, the browner complexion to some extent hides this red, which among darker peoples in other quarters of the world ceases to be discernible. Thus the difference between light and dark races is well observed in their blushing, which is caused by the rush of hot red blood into the vessels near the surface of the body. The contrary effect, paleness, caused by retreat of blood from the surface, is in like manner masked by dark tints of skin.

The range of complexion among mankind, beginning with the tint of the fair-whites of Northern Europe and the dark-whites of Southern Europe, passes to the brownish-yellow of the Malays, and the full-brown of American tribes, the deep-brown of Australians, and the black-brown of negroes. Until modern times these race-tints have generally been described with too little care. Now, however, the traveler, by using Broca's set of pattern-colors, records the color of any tribe he is observing, with the accuracy of a mercer matching a piece of silk. The evaporation from the human skin is accompanied by a smell which differs in different races. This peculiarity, which not only indicates difference in the secretions of the skin, but seems connected with liability to certain fevers, etc., is a race-character of some importance.

The part of the human body which shows the greatest variety of color in different individuals is the iris of the eye. This is the more noticeable because the adjacent parts vary particularly little among

mankind. Professor Broca, in his scale of colors of eyes, arranges shades of orange, green, blue, and violet-gray. But one has only to look closely into any eye to see the impossibility of recording its complex pattern of colors; indeed, what is done is to observe it from a distance, so that its tints blend into one uniform hue. It need hardly be said that what are popularly called black eyes are far from having the iris really black like the pupil; eyes described as black are commonly of the deepest shades of brown or violet. These so-called black eyes are by far the most numerous in the world, belonging not only to brown-black, brown, and yellow races, but even prevailing among the darker varieties of the white race, such as Greeks and Spaniards. In races with the darker skin and black hair, the darkest eyes generally prevail, while a fair complexion is usually accompanied by the lighter tints of iris, especially blue.

From ancient times, the color and form of the hair have been noticed as distinctive marks of race. Thus Strabo mentions the Ethiopians as black men with woolly hair, and Tacitus describes the German warriors of his day with their fierce blue eyes and tawny hair. As to color of hair, the most usual is black, or shades so dark as to be taken for black, which belongs not only to the dark-skinned Africans and Americans, but to the yellow Chinese and the dark-whites, such as Hindoos or Jews. In the fair-white peoples of Northern Europe, on the contrary, flaxen or chestnut hair prevails. Thus we see that there is a connection between fair hair and fair skin, and dark hair and dark skin. But it is impossible to lay down a rule for intermediate tints, for the red-brown or auburn hair common in fair-skinned peoples occurs among darker races, and dark-brown hair has a still wider range. Our own extremely mixed nation shows every

FIG. 7.—SECTIONS OF HAIR, HIGHLY MAGNIFIED (after Pruner). *a*, Japanese; *b*, German; *c*, African negro; *d*, Papuan.

variety, from flaxen and golden to raven black. As to the form of the hair, its well-known differences may be seen in the female portraits in Fig. 5, where the Africans on the left show the woolly or frizzy kind, where the hair naturally curls into little corkscrew spirals, while the Asiatic and American heads on the right have straight hair like a horse's mane. Between these extreme kinds are the flowing or wavy hair, and the curly hair which winds in large spirals; the English hair in the figure is rather of the latter variety. If cross-sections of single hairs are examined under the microscope, their differences of form are seen as in four of the sections by Pruner-Bey (Fig. 7). The almost

circular Mongolian hair (*a*) hangs straight; the more curly European hair (*b*) has an oval or elliptical section; the woolly African hair (*c*) is more flattened; while the frizzy Papuan hair (*d*) is a yet more extreme example of the flattened ribbon-like kind. Not only the color and form of the hair, but its quantity, vary in different races.

That certain races are constitutionally fit, and others unfit, for certain climates, is a fact which the English have but too good reason to know. It is well known that races are not affected alike by certain diseases. While in equatorial Africa or the West Indies, the coast-fever and yellow fever are so fatal or injurious to the new-come Europeans, the negroes, and even mulattoes, are almost untouched by this scourge of the white nations. On the other hand, we English look upon measles as a trifling complaint, and hear with astonishment of its being carried into Feejee, and there, aggravated, no doubt, by improper treatment, sweeping away the natives by thousands. It is plain that nations moving into a new climate, if they are to flourish, must become adapted in body to the new state of life. Fitness for a special climate, being matter of life or death to a race, must be reckoned among the chief of race-characters.

Travelers notice striking distinctions in the temper of races. There seems no difference of condition between the native Indian and the African negro in Brazil to make the brown man dull and sullen, while the black is overflowing with eagerness and gayety. So, in Europe, the unlikeness between the melancholy Russian peasant and the vivacious Italian can hardly depend altogether on climate and food and government. There seem to be in mankind inbred temperament and inbred capacity of mind. History points the great lesson that some races have marched on in civilization while others have stood still or fallen back, and we should partly look for an explanation of this in

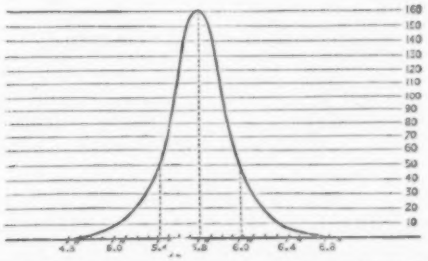


FIG. 8.—RACE OR POPULATION ARRANGED BY STATURE (Quetelet's method).

differences of intellectual and moral powers between such tribes as the native Americans and Africans, and the old-world nations who overmatch and subdue them. In measuring the minds of the lower races, a good test is, how far their children are able to take a civilized education. The account generally given by European teachers who have had the children of lower races in their schools is that, though these

often learn as well as the white children up to about twelve years old, they then fall off, and are left behind by the children of the ruling race.

It will be well now to examine more closely what a race is. Single portraits of men and women can only in a general way represent the nation they belong to, for no two of its individuals are really alike, not even brothers. What is looked for in such a race-portrait is the gen-

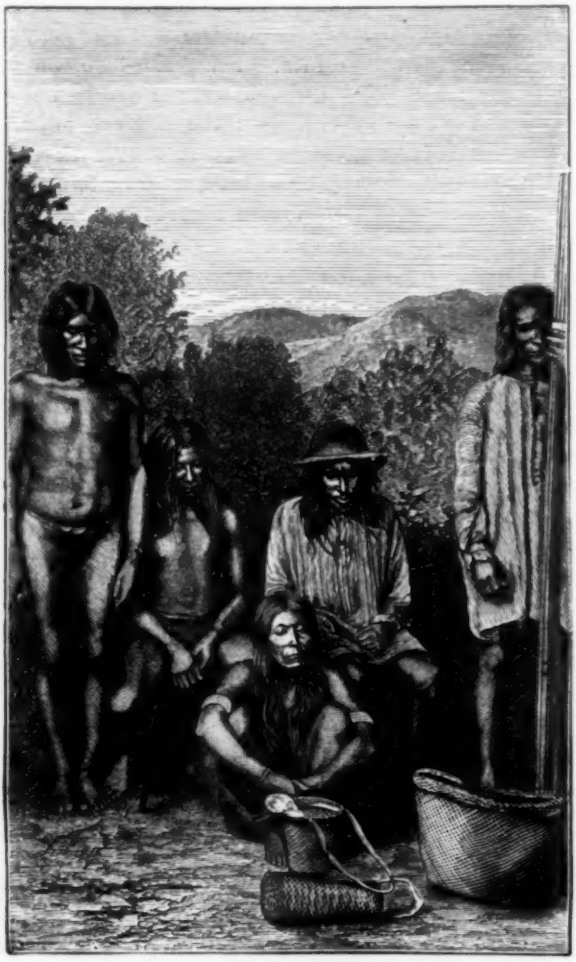


FIG. 9.—CARIBS.

eral character belonging to the whole race. It is an often-repeated observation of travelers that a European landing among some people unlike his own, such as Chinese, or Mexican Indians, at first thinks them all alike. After days of careful observation he makes out their individual peculiarities, but at first his attention is occupied with the

broad typical characters of the foreign race. It is just this broad type that the anthropologist desires to sketch and describe, and he selects as his examples such portraits of men and women as show it best. It is even possible to measure the type of a people. To give an idea of the working of this problem, let us suppose ourselves to be examining Scotchmen, and the first point to be settled how tall they are. Obviously there are some few as short as Lapps, and some as tall as Patagonians; these very short and tall men belong to the race, and yet are not its ordinary members. If, however, the whole population were measured and made to stand in order of height, there would be a crowd of men about five feet eight inches, but much fewer of either five feet four inches or six feet, and so on till the numbers decreased on either side to one or two giants, and one or two dwarfs. This is seen in Quetelet's diagram, Fig. 8, where the heights or ordinates of the binomial curve show the numbers of men of each stature, decreasing both ways from the central five feet eight inches, which is the stature of the mean or typical man. Here, in a total of near 2,600 men, there are 160 of five feet eight inches, but only about 150 of five feet seven inches or five feet nine inches, and so on, till not even ten men are found so short as five feet, or so tall as six feet four inches.

FIG. 10.—MALAY MOTHER AND HALF-CASTE DAUGHTERS.

It thus appears that a race is a body of people comprising a regular set of variations, which center round one representative type. In the same way a race or nation is estimated as to other characters.

The people whom it is easiest to represent by single portraits are

uncivilized tribes, in whose food and way of life there is little to cause difference between one man and another, and who have lived together and intermarried for many generations. Thus Fig. 9, taken from a photograph of a party of Caribs, is remarkable for the close likeness running through all. In such a nation the race-type is peculiarly easy to make out. It is by no means always thus easy to represent a whole population. To see how difficult it may be, one has only to look at an English crowd, with its endless diversity. But, to get a view of the problem of human varieties, it is best to attend to the simplest cases first, looking at some uniform and well-marked race, and asking what in the course of ages may happen to it.

The first thing to be noticed is its power of lasting. Where a people lives on in its own district, without too much change in habits, or mixture with other nations, there seems no reason to expect its type to alter. The Egyptian monuments show good instances of this permanence. Indeed, the ancient Egyptian race, who built the Pyramids, and whose life and toil are pictured on the walls of the tombs, are with little change still represented by the fellahs of the villages, who carry on the old labor under new tax-gatherers. Thus, too, the Ethiopians on the early Egyptian bass-reliefs may have their counterparts picked out still among the White Nile tribes, while we recognize in the figures of Phœnician or Israelite captives the familiar Jewish profile of our own day. Thus there is proof that a race may keep its special characters plainly recognizable for over thirty centuries, or a hundred generations. And this permanence of type may more or less remain when the race migrates far from its early home, as when African ne-

Fig. 11.—Cafusa Woman.

groes are carried into America, or Israelites naturalize themselves from Archangel to Singapore. Where marked change has taken place in the appearance of a nation, the cause of this change must be sought in intermarriage with foreigners, or altered conditions of life, or both.

The result of intermarriage or crossing of races is familiar to all

English people in one of its most conspicuous examples, the cross between white and negro called mulatto. The mulatto complexion and

FIG. 12.—AHETA (NEGRITO), PHILIPPINE ISLANDS.

hair are intermediate between those of the parents, and new intermediate grades of complexion appear in the children of white and

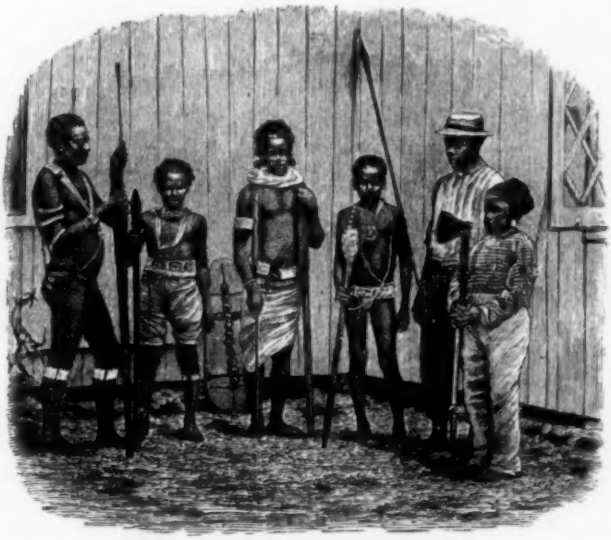


FIG. 13.—MELANESIANS.

mulatto, called quadroon or quarter-blood, and so on; on the other hand, the descendants of negro and mulatto, called sambo, return toward the full negro type. This intermediate character is the general nature of crossed races, but with more or less tendency to revert to one or other of the parent types. To illustrate this, Fig. 10 gives the portrait of a Malay mother and her half-caste daughters, the father being a Spaniard; here, while all the children show their mixed race, it is sometimes the European and sometimes the Malay cast of features that prevails. The effect of mixture is also traceable in the hair, as may often be well noticed in a mulatto's crimped, curly locks, between the straighter European and the woolly African kind. The Cafusas of Brazil, a peculiar cross between the native tribes of the land and the imported negro slaves, are remarkable for their hair, which rises in a curly mass, forming a natural periwig which obliges the wearers to stoop low in passing through their hut-doors. This is seen in the portrait of a Cafusa (Fig. 11), and seems easily accounted for by the long stiff hair of the native American having acquired in some degree the negro frizziness.

FIG. 14.—SOUTH AUSTRALIAN (Man).

FIG. 15.—SOUTH AUSTRALIAN (Woman).

Within the last few centuries it is well known that a large fraction of the world's population has actually come into existence by race-crossing. This is nowhere so evident as on the American Continent, where since the Spanish conquest such districts as Mexico are largely peopled by the mestizo descendants of Spaniards and native Americans, while the importation of African slaves in the West Indies has given rise to a mulatto population. By taking into account such inter-

crossing of races, anthropologists have a reason to give for the endless shades of diversity among mankind, without attempting the hopeless task of classifying every little uncertain group of men into a special race. Among the natives of India, a variety of complexion and feature is found which can not be classified exactly by race. But it must be remembered that several very distinct varieties of men have contributed to the population of the country. So in Europe, taking the fair nations of the Baltic and the dark nations of the Mediterranean as two distinct races or varieties, their intercrossing may explain the infinite diversity of brown hair and intermediate complexion to be met with. If, then, it may be considered that man was already divided into a few great main races in remote antiquity, their intermarriage

FIG. 16.—DRAVIDIAN HILL-MAN (after Fryer).

through ages since will go far to account for the innumerable slighter varieties which shade into one another.

It is not enough to look at a race of men as a mere body of people happening to have a common type or likeness. For the reason of their likeness is plain, and indeed our calling them a race means that we consider them a breed whose common nature is inherited from common ancestors. Now, experience of the animal world shows that a race or breed, while capable of carrying on its likeness from generation to generation, is also capable of varying. It must be admitted that our knowledge of the manner and causes of race-variation among mankind is still very imperfect. The great races, black, brown, yellow, white, had already settled into their well-known characters before

written record began, so that their formation is hidden far back in the prehistoric period. Nor are alterations of such amount known to have taken place in any people within the range of history.

That there is a real connection between the color of races and the climate they belong to, seems most likely from the so-called black peoples. Ancient writers were satisfied to account for the color of the Ethiopians by saying that the sun had burned them black, and, though modern anthropologists would not settle the question in this off-hand way, yet the map of the world shows that this darkest race-type is principally found in a tropical climate. The main line of black races

FIG. 17.—CALMUCK (after Goldsmid).

stretches along the hot and fertile regions of the equator, from Guinea in West Africa to that great island of the Eastern Archipelago, which has its name of New Guinea from its negro-like natives. The type of the African negro race perhaps shows itself most perfectly in the nations near the equator, as in Guinea, but it spreads far and wide over the continent, shading off by crossing with lighter-colored races on its borders, such as the Berbers in the north, and the Arabs on the east coast. As the race spreads southward into Congo and the Caffre regions, there is noticed a less full negro complexion and feature, look-

ing as though migration from the central region into new climates had somewhat modified the type. There are found in the Malay Peninsula and the Philippines scanty forest-tribes apparently allied to the Andamaners and classed under the general term Negritos (i. e., "little blacks"), seeming to belong to a race once widely spread over this part of the world, whose remnants have been driven by stronger newcome races to find refuge in the mountains. Fig. 12 represents one of them, an Aheta from the island of Luzon. Lastly come the widespread and complicated varieties of the Eastern negro race in the region known as Melanesia, the "black islands," extending from New Guinea to Feejee. The group of various islanders (Fig. 13), belonging to Bishop

FIG. 18.—COREANS.

Patteson's mission, shows plainly the resemblance to the African negro, though with some marked points of difference, as in the brows being more strongly ridged, and the nose being more prominent, even aquiline—a striking contrast to the African. The great variety of color in Melanesia, from the full brown-black down to chocolate or nut-brown, shows that there has been much crossing with lighter populations. Finally, the Tasmanians were a distant outlying population belonging to the Eastern blacks.

In Australia, there appears a thin population of roaming savages,

strongly distinct from the blacker races of New Guinea at the north, and Tasmania at the south. The Australians, with skin of dark chocolate-color, may be taken as a special type of the brown races of man. While their skull is narrow and prognathous like the negro's, it differs from it in special points, and has peculiarities which distinguish it very certainly from that of other races. In the portraits of Australians (Figs. 14, 15), there may be noticed the heavy brows and projecting jaws, the wide but not flat nose, the full lips, and the curly but not woolly black hair. On the continent of India, the Dravidian hill-tribes present the type of the old dwellers in South and Central India before the conquest by the Aryan Hindoos. Fig. 16 represents one of the ruder Dravidians, from the Travancore forests.

FIG. 19.—FINN (Man).

FIG. 20.—FINN (Woman).

The Mongoloid type of man has its best marked representatives on the vast steppes of Northern Asia. Their skin is brownish-yellow, the hair of the head black, coarse, and long, but face-hair scanty. Their skull is characterized by breadth, projection of cheek-bones, and forward position of the outer edge of the orbits, which, as well as the slightness of brow-ridges, the slanting aperture of the eyes, and the snub-nose, are observable in Fig. 17, and in Fig. 5 (*d*). The Mongoloid race is immense in range and numbers. The great nations of South-east Asia show their connection with it in the familiar complexion and features of the Chinese and Japanese. Fig. 18 gives portraits from Corea. In his wide migrations over the world, the Mongoloid, through change of climate and life, and still further by intermarriage with

other races, loses more and more of his special points. It is so in the southeast, where in China and Japan the characteristic breadth of skull is lessened. In Europe, where from remotest antiquity hordes of Tartar race have poured in, their descendants have often preserved in their languages, such as Hungarian and Finnish, clearer traces of their Asiatic home than can be made out in their present types of com-

FIG. 21.—DYAKS.

plexion and feature. Yet the Finns (Figs. 19 and 20) have not lost the race-differences which mark them off from the Swedes among whom they dwell, and the stunted Lapps show some points of likeness to their Siberian kinsfolk.

On the Malay Peninsula, at the extreme southeast corner of Asia, appear the first members of the Malay race, seemingly a distant branch

of the Mongoloid, which spreads over Sumatra, Java, and other islands of the Eastern Archipelago. Fig. 21 shows the Dyaks of Borneo, who represent the race in its wilder and perhaps less mixed state. The Micronesians and Polynesians show connection with the Malays in language, and more or less in bodily make. But they are not Malays proper, and there are seen among them high faces, narrow noses, and small mouths, which remind us of the European face. The Maoris

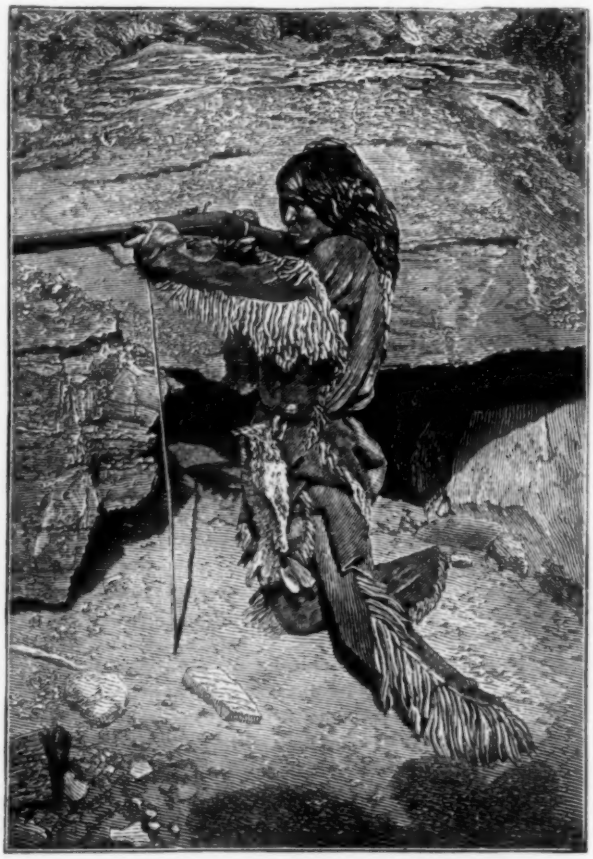


FIG. 22.—COLORADO INDIAN (North America).

are still further from being pure Malays, as is seen by their more curly hair, often prominent and even aquiline noses.

Turning now to the double continent of America, we find in this New World a problem of race remarkably different from that of the Old World. The traveler who should cross the earth from Nova Zembla to the Cape of Good Hope or Van Diemen's Land would find in its various climates various strongly-marked kinds of men, white, yellow, brown, and black. But, if Columbus had surveyed America from

the Arctic to the Antarctic regions, he would have found no such extreme unlikeness in the inhabitants. Apart from the Europeans and Africans who have poured in since the fifteenth century, the native Americans in general might be, as has often been said, of one race. Not that they are all alike, but their differences in stature, form of skull, feature, and complexion, though considerable, seem variations of a secondary kind. The race to which most anthropologists refer the native Americans is the Mongoloid of Eastern Asia, who are capable of accommodating themselves to the extremest climates, and who by the form of skull, the light-brown skin, straight black hair, and black eyes, show considerable agreement with the American tribes. Fig.

FIG. 23.—SWEDES.

22 represents the wild hunting-tribes of North America in one of the finest forms now existing, the Colorado Indians.

Though commonly spoken of as one variety of mankind, it is plain that the white men are not a single uniform race, but a varied and mixed population. It is a step toward classing them to separate them into two great divisions, the dark-whites and fair-whites (*melanochroi*, *xanthochroi*). Ancient portraits have come down to us of the dark-white nations, as Assyrians, Phœnicians, Persians, Greeks, Romans; and when beside these are placed moderns such as the Andalusians, and the dark Welshmen or Bretons, and people from the Caucasus, it will be evident that the resemblance running through all these can only be in broad and general characters. They have a dusky or

brownish-white skin, black or deep-brown eyes, black hair, mostly wavy or curly; their skulls vary much in proportions, though seldom extremely broad or narrow, while the profile is upright, the nose straight or aquiline, the lips less full than in other races. Fig. 23, a group of Swedes, represents the fair-whites, whose transparent skin, flaxen hair, and blue eyes may be seen as well, though not as often, in England as in Scandinavia or North Germany. The intermarriage of the dark and fair varieties, which has gone on since early times, has resulted in numberless varieties of brown-haired people, between fair and dark in complexion. But as to the origin and first home of the fair and dark races

FIG. 24.—GYPSY.

themselves, it is hard to form an opinion. Language does much toward tracing the early history of the white nations, but it does not clear up the difficulty of separating fair-whites from dark-whites. Both sorts have been living united by national language, as at this day German is spoken by the fair Hanoverian and the darker Austrian. Among Keltic people, the Scotch Highlanders often remind us of the tall, red-haired Gauls described in classical history, but there are also passages which prove that smaller darker Kelts like the modern Welsh and Bretons existed then as well. A mixture of the white and brown races seems to have largely formed the population of countries where they meet. The Moors of North Africa, and many so-called Arabs

who are darker than white men, may be thus accounted for. It is thus that in India millions who speak Hindoo languages show by their tint that their race is mixed between that of the Aryan conquerors of the land and its darker indigenes. An instructive instance of this very combination is to be seen in the gypsies, low-caste wanderers who found their way from India and spread over Europe not many centuries since. Fig. 24, a gypsy woman from Wallachia, is a favorable type of these latest incomers from the East, whose broken-down Hindoo dialect shows that part of their ancestry comes from our Aryan forefathers, while their complexion, swarthiest in the population of our country, marks also descent belonging to a darker zone of the human species.

Thus to map out the nations of the world among a few main varieties of man, and their combinations, is, in spite of its difficulty and uncertainty, a profitable task. But to account for the origin of these great primary varieties or races themselves, and exactly to assign to them their earliest homes, can not be usefully attempted in the present scantiness of evidence.

EUROPEAN SCHOOLS OF FORESTRY.

By N. H. EGLESTON.

THE word "forestry" has not yet come into familiar use in this country, and its meaning is understood only by the few; "school of forestry" is still less comprehensible. It is only natural that our people, occupying a region covered to a great extent with a dense and varied growth of trees, in regard to which no apprehension of deficiency has been suggested until within a comparatively short time, should have entertained little thought of the forest as a thing to be specially cared for and cultivated. Much less should it have occurred to them to make its maintenance an object of scientific study, to put the school and the wood, education and trees, into close association, and to think and speak of "schools of forestry."

Both these terms, however, are well understood abroad, and the time has come, in the changed condition of things here, when we should know what they mean, and that practically.

The "school of forestry," or whatever equivalent may be used in different countries, signifies an organization for the purpose of giving instruction in regard to all that pertains to the growth of trees, especially in masses, and their management, including their natural history, their adaptation to the arts, and their influence upon human welfare. It regards the forest in altogether a different light from that in which it is considered with us, or in fact from that in which it has been considered in any country until within a comparatively recent pe-

riod. Instead of an accidental growth of trees, spared from the general clearing of the ground, which have been suffered to come up in a hap-hazard sort of way, exposed to assault and damage of various kinds, from insects, from browsing cattle allowed to roam freely among them, and from the carelessness, if not the wanton waste, of man, the forest is regarded as a growth carefully provided for, the conditions of its increase are diligently studied beforehand, and all means are used to develop it to the fullest measure of its value according to the purpose for which its cultivation has been undertaken. In short, forestry looks upon the growth of a piece of woods as we look upon the growth of plants in a garden, or a crop in the field of a farmer, as the result both of science and art. Only it is a nobler growth than these, and requires a higher science and nicer art, inasmuch as the trees measure their age by centuries and not by months or seasons, as do the ordinary crops of the garden and the field, and because they have important relations, controlling relations even to agriculture itself, to climate, to commerce, and the industrial arts, and so to the highest interests of national life.

The work of forestry, as understood in Europe, contemplates not only the proper care of existing woodlands, but the replanting of districts which have been stripped of their forests, and also the planting of forests in new places, where such planting may be advantageously done. Schools of forestry have their origin in the desire to accomplish this most successfully. The growth of a forest is the work of a century, and even more. It is not properly to be undertaken with only the limited intelligence or care with which we cultivate the annual crops of our fields. If the work is begun without adequate preparation, or is conducted in a faulty manner, the mistake can not be remedied soon, if at all. If one makes a mistake in the culture of ordinary crops, he can correct it the next year; but, if he plants a forest on an erroneous plan, the mistake is not one of a year, but of a hundred, or even two hundred years. Not only is it necessary that the botany of the trees should be understood, the nature and habits of the various species be studied, and their adaptations to different soils and situations, as well as to different practical uses when grown, be regarded, but the laws of meteorology are to be considered and conformed to. The knowledge of geology and mineralogy is also involved, as well as the laws of mechanics. Indeed, no sooner is the subject taken into consideration in its true character, than it is seen to be interwoven with a very large range of studies, so that something like schools of forestry seem almost at once desirable, if not indispensable.

The beginning of forest schools may be dated from 1770, when Frederick the Great established a course of theoretical instruction in forestry at Berlin. This, however, was irregular, dependent upon the competency of the professors at the university, for the time being, to

give instruction upon the subject. The course was greatly deficient, at the best, on account of its entire lack of technical teaching. This defect, felt more and more, finally led to the establishment of an academy for forest instruction at Berlin in 1821, under the general superintendence of Pfeil, then *Oberforstrath*. The academy was not organically connected with the university, but was brought into such an association with it that the professors and apparatus of instruction belonging to the university could be used for teaching the fundamental and accessory sciences, while technical forestry was taught by professors in the academy specially qualified for the work. This arrangement, however, did not prove satisfactory. Too much prominence was given to the accessory sciences, and too little to forestry proper. Especially was the lack of sufficient instruction in practical forestry felt, there being no suitable woodland in the neighborhood of Berlin in which the theoretical instruction could be practically illustrated and applied. Excursions to distant forests, which could be made only infrequently, did not meet the want. On the advice of the superintendent, seconded by the energetic support of the two Humboldts, the academy was removed in 1830 to Neustadt-Eberswalde, about twenty-four miles northeast of Berlin, under the name of the High Institution for Forest Science. The school was now in the immediate vicinity of two large forest districts, affording every facility for instruction in practical forestry. The superintendent of the academy was made also administrator of the forest districts. Associated with him, as instructor in forestry proper, were two others as teachers of the natural sciences and of mathematics and geodesy. At the same time a teacher of Prussian jurisprudence, with particular reference to forest matters, was added, and, after an interval of twenty years, a second teacher of forest science was appointed. Since 1866 important changes have been made in the organization of the academy, and the number of instructors has been largely increased. There are now three teachers of forest science, a teacher of mathematics, physics, mechanics, and meteorology; one of chemistry, mineralogy, and geognosy; one of botany, one of zoölogy, and one of jurisprudence. In addition, there are a royal chief forest officer, as assistant teacher of road-construction, geodesy, and plan-drawing, and also a chemist as assistant teacher of geology. The principal forest meteorological station of Germany is also in connection with this school.

The course of instruction in the schools of forestry extends from two years to two and a half, or five semesters, the tendency having been constantly to protract the time. The course at Neustadt-Eberswalde embraces five semesters. The branches taught are arranged in three groups, viz., "Fundamental Sciences," "Principal Sciences," and "Secondary Sciences." Under the heading of "Fundamental Sciences" are included: *1. Natural Sciences.*—Chemistry, theoretic and applied; physics and meteorology; mineralogy and geognosy; botany, and

forest botany in particular, with anatomy of plants, vegetable physiology and pathology, and botanical excursions; microscopy; zoölogy, with especial study of forest insects, preparations, and excursions: to all of which 840 hours are allotted. *2. Mathematics.*—Geodesy; interest and rent account; wood-measuring; surveying and leveling exercises; plan-drawing exercises: 440 hours. *3. Economical Sciences.*—Public economy and finances: 48 hours. Whole time allotted to "Fundamental Sciences," 1,328 hours. In the "Principal Sciences" are included what relate especially to forests, their cultivation, protection, technics in various branches, legal and customary usages, etc., with forest excursions: to all of which 980 hours are allotted. In the "Secondary Sciences" are jurisprudence (civil and criminal law, constitutional rights, etc.), construction of roads, and shooting exercises: to which 340 hours are given. Of the total, 2,648 hours of instruction, 50 per cent. are given to the "fundamental," 37 per cent. to the "principal," and 13 per cent. to the "secondary" sciences. The average time of lessons, counting the five semesters as including ninety-three weeks, is 28·5 hours per week, or 4·9 hours per day. From this it will be seen that nearly five hours are given to lectures each day. Nearly as much more time is expected to be given to study, making almost ten hours of daily work for the students. If we compare this with the average time during which the students in our colleges are employed, it will be seen that a course of instruction at one of these forest academies is more than equivalent, in the amount of work done, to an ordinary college course.

The forest schools, as at present existing, may be divided into three classes, according as they are forest schools strictly and independently—that is, schools situated in the forest as well as teaching the art of forest management—or as they form only a part of the general course of instruction at the university or polytechnic school; or as, again, they are united with agricultural schools, and the attempt is made to teach forestry and agriculture together. There has been of late years a good deal of discussion, in Germany especially, as to which of these arrangements is to be preferred. The academies at Neustadt-Eberswalde, Münden, Eisenach, and at Nancy, in France, are examples of the first class. Those at Giessen, at the Polytechnic School at Zürich and the projected arrangement at the university of Munich, are examples of the second class; while the establishments at Hohenheim, Vienna, St. Petersburg, and Stockholm, are examples of the third class.

On behalf of the first class it is urged that when the academy is located in the forest there will be greater facilities for the practical study of all that relates to the growth of trees, their influence upon climate, and the like. On behalf of a connection of the forest academies with the universities and polytechnic schools or with schools of agriculture, it is urged that this would be an economical arrange-

ment because only the technical teaching of forestry would have to be provided for, instruction in the fundamental and allied sciences being already abundantly secured in the necessary endowment of the ordinary educational establishments. The argument for the union of the separate forest schools with the universities, as put by Dr. Richard Hess, formerly Professor of Forestry and now director of the Forestry Department of the University of Giessen, in a recent work of his, may be taken as a fair exhibition of the reasoning of those who favor the union of the forest schools with the universities. He claims that the universities can always command for their various chairs men of the highest ability, and this, in the first place, because the position of such a professor is the most independent one, the instructors in the forest schools being dependent upon the director; secondly, because the universities have better libraries and apparatus than the forest schools can have by themselves; thirdly, the natural stimulation of colleagues in allied chairs is a powerful motive to excellence; fourthly, the latest developments of science in the related departments of instruction will be found in the universities; fifthly, the professors in connection with the universities receive a better income than those in the isolated forest schools; and, finally, the academic atmosphere of the great university is of value, and helpful to professors and students alike. These reasons are forcibly urged in addition to those economical considerations which we have already mentioned. Professor Hess also adduces the practical fact that the forests of Hesse show the very best management, and are visited by foresters from abroad on this account, and that the forest management of Hesse took a high position at the Congress of Foresters held in connection with the Vienna Exposition in 1873.

The tendency of opinion, especially in the central and southern portions of Germany, seems to be in favor of attaching the forest academies to the universities. More and more there is demanded, in those who are called to important positions in the forestry service, the most thorough academical education, and one now has very little chance of gaining a high position in the management of the government forests who has not had a complete university education. Without this he can hope to occupy only a subordinate place. The tendency of the opinion of those most competent to judge in the case is shown also by the fact that at a convention of foresters held at Freyburg in 1874, and numbering three hundred and sixty-nine members, it was declared unanimously that the isolated system of forest instruction will no longer suffice, and the study of forestry in connection with the universities was favored.

One of the most recently established schools is that at Münden under the directorship of Dr. Gustav Heyer. Its management is like that at Neustadt-Eberswalde, and the average number of students has been about seventy-five. The Central Forest Institute at Aschaffen-

burg, Bavaria, one of the most distinguished schools, has grown out of a forest institute established originally in 1807, which by a decree of the Government in 1874 was united with the University of Munich. It is under the direction of Stumpf, who is assisted by five professors. This school has had the benefit and honor of the labors of Dr. Ernst Ebermayer, whose work on the "Physical Influences of Forests on the Earth and Air," published in 1873, in two volumes octavo, ranks as one of the most important treatises upon this subject.

The Royal Saxon Forest Academy at Tharandt is justly distinguished. It is now under the care of Dr. J. F. Judeich, who was president of the jury of award on exhibitions of forestry at Vienna in 1873. The course of instruction occupies two years and a half, under a director aided by four professors and two assistants. The average attendance of students is about fifty, more than half of whom are foreigners. The number in attendance has lately been much increased, and several Americans are reported among them.

In Würtemberg is the agricultural and forestral academy at Hohenheim, which has grown out of two separate institutions founded in 1818, and united two years afterward. It was reorganized in 1865, and is now one of the most important of the German schools, its course of instruction both in agriculture and forestry being very full. It is located on a princely estate near Stuttgart. It has a noble park of twenty acres, and extensive plantations or nurseries of trees and plants both native and foreign. Between seven and eight hundred acres of land are devoted to the purposes of agriculture, and between five and six thousand acres are devoted to the study and uses of forestry. This academy is probably the best specimen which Germany affords of the combined agricultural and forestral school. It has extensive and valuable collections. Its course of instruction extends to two and a half years. Its faculty consists of a director, nine professors and seven adjunct professors, two reviewers, and one assistant.

Professor Mathieu, of Nancy, describing this institution in the "Review of Woods and Forests," says: "The little kingdom of Würtemberg, with scarcely two million of inhabitants, has spared nothing in providing itself with whatever could contribute to the success of instruction or to the progress of science. This truly liberal spirit has led to the establishment of magnificent agricultural galleries, where we find collected, to the number of sixteen hundred, the various tools and machines employed in labors of the field; elegant rooms filled with forestral collections, implements, woods, and various products; cabinets in botany, zoölogy, mineralogy, and geology; instruments for use in studies of physics and geodesy; a station for experiments concerning woods, and another for meteorology. Its library numbers five thousand five hundred volumes, and its reading-room contains numerous periodicals in all languages, of which forty-nine are scientific,

agricultural, or forestral journals, and thirty-five are of the political, literary, or illustrated class."

The design of this academy is, in the words of another, "to impart a thorough, practical, and professional education to those who are to become the owners or managers of estates, and to farmers and foresters in public or private service, and to enable them to become champions of progress among their colleagues in business."

At the University of Tübingen, a chair of Agriculture and Forestry has existed since 1817.

The Polytechnic School at Carlsruhe, in Baden, has a department of forestry, with two professors. From thirty-five to forty students attend, of whom about one fifth are foreigners. The requirements for admission are as follows: Citizens of the state, who wish to enter the state forestry service, after attending a full course at the gymnasium, are admitted, and must pass through a course of four years, of which the first two are devoted to those fundamental and auxiliary studies which do not relate directly to forest-science, but which serve as a preparation for the remaining two years' studies, or the forest-course proper. Foreigners may attend the first two years or not, as they prefer. An age of seventeen years is required for admission. At the close of the second year the state students must pass an examination in natural philosophy and mathematics; but if they fail they are allowed one more trial. This examination entitles them to enter upon the last two years of special forest studies, in which they are taught agriculture, forest jurisprudence, and the higher mathematics, when they are again examined, and, if passed, are qualified for a place in the state service. The examination at the end of the first two years is by the professors of the polytechnic school, and the final examination by the forest directors, a person skilled in law, a professor of agriculture, a professor of forest management, and two professors of mathematics.

After passing all examinations, the candidate is assigned to the general district foresters as an assistant, to enable him to become practically acquainted with his duties, and he receives a tract of forest to manage. After six to ten years, according to the number waiting, he gets a position as general district forester. The number of forest districts in Baden at present is one hundred and ten, to about four of which appointments are made annually. The Forest Direction has its seat in Carlsruhe, and is composed of six members, who are inspectors.

The aids to instruction at this forest school are a valuable collection of objects pertaining to the subject, a chemical and physiological laboratory, to which a greenhouse is annexed, and a forest garden. The area of forests in Baden is 1,262,493 acres.

A school of forestry was established in connection with the University of Giessen, in Hesse-Darmstadt, in 1825, with two chairs of forestry and a course of three years. In 1831 this school was united

with the university, of which it now forms a department. The fundamental and auxiliary sciences, mathematics, natural sciences, chemistry, agriculture, law, etc., are taught by the professors of the university, while those studies that immediately relate to forestry come within the care of this special department.

The academic forest garden occupies six hectares, and Giessen and Schiffenberg forest-reviers in the neighborhood afford opportunities for practical study. The course of instruction extends through two years. Two excursions are made weekly, at which the subject of the lectures is practically illustrated, and the various operations of sylviculture are shown. Besides these, journeys of one or two weeks at a time are taken in summer, under the guidance of one of the teachers. The students of the forest institute enjoy the same rights as those of the university. The average attendance in the forestry department for several years past has been only about fifteen.

In the Grand-duchy of Saxe-Weimar is a forest institute, at Eisenach, with three professors and a course of instruction extending through three semesters. This institute was founded as a private school in 1808 by Oberforstrath König, at Rhula, but was made a state institution in 1830.

The Ducal Polytechnic School of Brunswick, founded in 1745 by Duke Charles I, and the first polytechnic school ever established, has a department of forestry.

In addition to these forest schools of the first order, as they may be termed, are subordinate schools at Weihmstephan and at Lichtenhof, near Nuremberg, besides numerous academies and private schools in which the principles of forestry are taught. Many forestry associations also, in one way or another, encourage the study of this science.

When we consider the limited territory of Germany, as compared with our own country, one can not take even this cursory observation of its forest schools without having the conviction impressed upon him that forestry is there regarded as a subject of the first importance, and that it has interests and relations which are very much if not altogether overlooked by us.

France has an eminent forest school at Nancy, which was established more than fifty years ago, and has a director and ten professors. It is designed to prepare agents for the state forest service, and foresters for the management of forests belonging to communes and public establishments. The number of pupils admitted is regulated by the wants of the administration from time to time. During the last fifty years, the school has graduated about a thousand men. In addition to those admitted to be trained for the public service, a certain number are admitted who are called *externes*. Great Britain, which has no school of forestry of her own, sends annually to Nancy from five to ten pupils to be trained for the management of her forests in India, and in the South African and other colonies.

The course of instruction at Nancy covers two years, and is very much like that at the German schools.

Another school, called the school of Forest Guards, at Barres, was established in 1865, by the Director-General of Forests, on what had been the estate of an eminent arboriculturist, M. Vilmorin. It has been reorganized recently and its plan has been extended.

An Agronomic Institute has been established lately at the Conservatory of Arts and Trades at Paris, having for its object the advancement of agriculture. It has fifteen professors, several of whom will be instructors of forestry in some of its branches. In addition to the instruction in forestry thus given, the French forestry administration is accustomed to send out agents to instruct classes in forestry at several of the agricultural schools. There are also inferior forest schools for the education of subaltern foresters at Grenoble and Villers-Cotterets.

The Austrian Empire is second only to Germany in the abundance and character of its forest schools and in the general interest taken in the subject of forestry. At the head of the Austrian schools stands the Imperial High School of Agriculture and Forestry at Vienna. This was founded by a royal decree of 1872, upon the basis of a reorganized forest school originally established at Mariabrunn, near Vienna, at the entrance of the beautiful Wienerwald. The school occupied an old monastery, and in it were gathered the amplest apparatus for study, including very fine museums and collections. By the decree of 1872 this school was united with the Agricultural College of Vienna, and the two now constitute one school in two sections. The agricultural section was opened in 1872, the forest section in 1875. The consolidated institution is designed to give the best instruction both in agriculture and forestry. The course of instruction extends over three years. Two classes of students are admitted: the ordinary, who must bring a certificate that they have completed a course at a gymnasium or upper real-school, or a department school of equal rank; and the extraordinary, who must have sufficient preparatory training at least to enable them to understand the lectures, and who must have reached the age of seventeen years. The latter class are also obliged to pay tuition fees and can not receive the state stipends of which the ordinary pupils may avail themselves.

What are called secondary schools of forestry are established at Weisswasser in Bohemia, Eulenberg in Moravia, and at Lemberg in Galicia. These schools are formed on the German model. The course of instruction embraces two years. The requirements for admission are attendance for one year at a lower real-school or gymnasium, and in some cases a year's forest practice besides. Tuition is practically free.

There are also schools of forestry in Hungary. One is the Royal Hungarian Mining and Forest Academy at Schemnitz, which has been

developed from a School of Mines established as long ago as 1765. A forest institute was begun in 1807. Reorganizations have frequently taken place, until now the course of instruction is divided into six classes, two of which relate to forestry and forest engineering. The whole course is arranged for four years. From a memorial volume published recently, and soon after the celebration of the first centennial of the academy, it appears that it has graduated 5,373 pupils. The average annual attendance in recent years has been about 150.

Other schools of a lower grade, having a course of instruction of only one year in extent, are established at Aggsbach, in Lower Austria, and at Wildalpen, in Styria.

The Austro-Hungarian Empire has also many societies, which, though not schools of forestry, have a more or less direct relation to that subject and do much to promote it. Such are the Forest Society of the Tyrol, the Forestry Association of Manhartsburg, in Lower Austria, the Vienna Joint Stock Company for Forestry, the Forestry Company of Styria and Carinthia, the Association of Moravia and Bohemia, the Society of Western Galicia, and several others. In Croatia is a School of Agriculture and Forestry, with five professors, and a course of study of three years.

The Federal Union of the Swiss Cantons established a Polytechnic School at Zürich in 1855, in which a school of forestry forms the fifth division of instruction. The course of teaching extends to two years and a half. The separate cantons also make provision for elementary instruction in the science and art of forestry; and still further provision is made for the teaching of the subject. As different states or kingdoms have a common interest in the navigation of a river which flows through their territories, and will rightly insist upon its being unimpeded, so it has been found by the cantons that they often have a common interest in the preservation of forests which may be situated in separate cantons, because their effects reach far beyond their particular locality. One canton might be more harmed by the destruction of a forest belonging to another canton than that canton itself. Accordingly, through the influence of the Swiss Forestry Association and the help of others acting with them, the Federal Constitution was amended in 1873, by the adoption of an article declaring that "the Federal Union has the right of supervising structures for the protection of watercourses and of the forest police in the mountain-regions." In the exercise of this right, the Union in 1876 enacted a comprehensive law, embodied in thirty-one distinct articles, relating to the high surveillance of the Confederation over the police of forests in the elevated regions.

For the more effectual carrying out of this law, provision was made in the same year for holding what may be called forest institutes, in the several cantons, during two months every year. At these institutes practical instruction is given in forestry, little if any attention being

bestowed on theories. The course of instruction embraces the following subjects, and we give the schedule, as suggesting what perhaps may be profitably done in this country at present, and while waiting for the establishment of fully endowed forest schools.

1. Forest surveys; the marking out of woodlands; measurement and calculation of small areas, as also of the trunks of trees, linear distances, etc.; estimation of single trees and parcels of forest, as to quantity and value; making of forest roads; means of shielding forests against avalanches and small slides.

2. Study of the kinds of wood and of injurious herbs that should be known by sub-foresters.

3. Elementary study of the soil, and of the relations between different kinds of soils, and of the nature of different tracts of land.

4. Indispensable ideas of climatology and meteorology.

5. Cultivation and management of forests.

6. The information most important to sub-foresters concerning the working of forests, forest police and protection, and book-keeping.

7. The number of pupils shall not exceed thirty.

The applicants must be at least eighteen years of age, and must pass an examination in the primary studies as taught at the best schools; and, if, at the end of the course of instruction, they are approved, they receive a certificate which puts them in the way of an appointment to the care of the high forests of which the Confederation has assumed the control, or of the forests still managed by the cantons separately, or by other corporations.

The teachers of these institutes are appointed by the cantons, subject to the approval of the Federal authority, but they are paid from the general treasury.

Italy, which has suffered greatly from the removal of her forests, and has taken action similar to that of the Swiss Confederation for their control, has an Institute of Forestry in the vale of Vallombrosa. It is situated in a noble wood of firs, high upon the slope of the Apennines, near the source of the Arno, where it puts to good use an old convent. In its plan of instruction the institute at Vallombrosa is much like that at Nancy.

Distinguished as Sweden is for her interest in education, statistics showing that at the present time only three per cent. of her criminals even are without school-training, we should expect that she would not be behind other countries in the matter of forestral instruction; nor is she. A competent observer tells us that of late years "strenuous and successful endeavors have been made to introduce into the management of the forests the latest improvements adopted in Germany and France, and to regulate the national forest economy in accordance with the most advanced forest science of the day." The system of instruction established embraces a Forest Institute at Stockholm, which, in the

language of the royal ordinance for its management, "has for its end to educate able forest managers by free instruction"; subordinate to this, a system of district forest schools, of which the same ordinance says, "The aim of these forest schools is, through gratis instruction, to form good foresters"; and, finally, the common schools, together with private elementary schools of forestry, aided to some extent by the Government.

The Forest Institute at Stockholm ranks with the best forest schools of Europe. Its course of instruction and its management are so nearly like those in use at Nancy, at Neustadt-Eberswalde, and elsewhere, that we need not speak of them in detail.

The district forest schools are established at suitable points in the public forests. They are under the oversight of the Forest Bureau, and each under the visitation of the forest inspector in whose district of service the school is situated. Each forest school is presided over by a president, who is at the same time the teacher of the school, with a forest overseer as his assistant. The course of instruction embraces one full year, at the end of which the pupils have a public examination. In 1874 there were seven schools of this kind. There were alse thirteen private elementary schools of forestry, supported in part by government aid. It is also a noticeable feature of the system of education in Sweden that horticulture and tree-planting are taught in the Falk schools, or common schools. From the report of 1873 we find that in that year 59,860 pupils received such instruction. The same ratio would give 600,000 pupils for the United States.

Spain and Portugal, ranking lowest almost of all European countries in the proportion of their forest area to their total surface, the one having, on the authority of Reutzsch, 5·52, and the other 4·40 per cent., are yet not without their forest schools. A School of Forest Engineers was established in 1846, at Villaviciosa, not far from Madrid. In 1869 it was transferred to San Lorenzo del Escurial. It is under the direction of the Minister of Agriculture. Is has a director, nine professors, and two assistants. The course of instruction extends to three years.

An Agricultural Institute was founded at Lisbon in 1852. It was reorganized in 1865 as the General Institute of Agriculture. The course of instruction embraces rural engineering, sylviculture, agronomy, forest engineering, and veterinary medicine. The corps of instruction consists of ten professors and five substitutes, as they are called. The institute is well furnished with grounds, cabinets, and collections adapted to give practical instruction in the studies taught.

Denmark and Finland also have their schools of forestry, the one at Copenhagen, under the title of the Royal Veterinary and Agricultural High School, and the other at Evois.

Russia has several schools scattered throughout her vast territory.

For although her forests, particularly in the northern portion, seem inexhaustible, yet even among these the waste by accidental and designed burnings has at length shown the necessity of care and economy in forestry management. The forests of Russia have been swept off year by year by fires until portions of the country are suffering in a change of climate and in other respects as the consequence. The Volga is diminished in volume; navigation is becoming more difficult; fuel is getting scarce; and the services of those trained in forest schools are needed in Russia almost as much as they are in Italy or Spain.

The Agronomic Institute at St. Petersburg is designed to give the best education in both agriculture and sylviculture, and is organized for this purpose in two sections. Those admitted to it must have finished a course of instruction at some gymnasium. It has one hundred and fifty students in the forestry section, a three years' course of study, and graduates annually about forty pupils.

The Agricultural and Forestral Academy at Petrovsk, near Moscow, founded in 1865, is similar in character and course of instruction to the institute at St. Petersburg. In 1872 it had three hundred and thirty-three pupils in attendance.

About fifty miles from St. Petersburg is the forest school of Lissino, a school of the second class, whose graduates receive the rank of forest conductors. The course of studies is of a practical character, and is of three years in extent.*

* This sketch gives a partial idea of the importance that is attached to forestry in countries whose age and experience have carried them beyond the stage of wasteful expenditure of resources in wood through which we are passing, to the point where necessity compels them to do all that is possible to make amends for their former recklessness, and to endeavor by every means to restore what they have lost. The trees are recognized as one of man's most valuable inheritances—with which his fortunes, public and private, are intimately associated; and no interest in state or nation is paramount to that of having them preserved and properly cared for. The sources of information in regard to forestry and forest schools are of course as yet chiefly foreign. J. Croumbie Brown, of Haddington, England, for some time Government botanist at the Cape of Good Hope, has published several volumes bearing more or less directly on the subject. Hon. C. C. Andrews, late Minister to Sweden and Norway, has made a valuable report to the Department of State on the forests and forest-culture of Sweden. A report on forests and forestry, in connection with the International Exhibition at Vienna, in 1873, has also been made by John A. Warder, one of our commissioners. A voluminous report upon forestry has also been made, under the direction of the Commissioner of Agriculture, in pursuance of an act of Congress of 1876, by Franklin B. Hough, which contains a large amount of valuable information. We have drawn from these, in addition to the numerous French and German publications on forestry, for the facts here given in regard to forest schools.

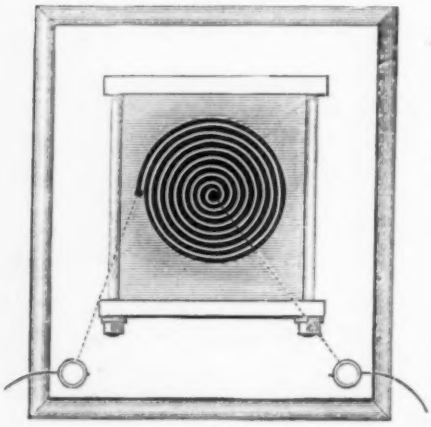
PRODUCTION OF SOUND BY RADIANT ENERGY.*

By ALEXANDER GRAHAM BELL.

AT the time of my communication to the American Association† the loudest effects obtained were produced by the use of selenium, arranged in a cell of suitable construction, and placed in a galvanic circuit with a telephone. Upon allowing an intermittent beam of sunlight to fall upon the selenium, a musical tone of great intensity was produced from the telephone connected with it.

But the selenium was very inconstant in its action. It was rarely, if ever, found to be the case that two pieces of selenium (even of the same stick) yielded the same results under identical circumstances of annealing, etc. While in Europe last autumn, Dr. Chichester Bell, of University College, London, suggested to me that this inconstancy of result might be due to chemical impurities in the selenium used. Dr. Bell has since visited my laboratory in Washington, and has made a chemical examination of the various samples of selenium I had collected from different parts of the world. As I understand it to be his intention to publish the results of this analysis very soon, I shall make no further mention of his investigation than to state that he has found sulphur, iron, lead, and arsenic in the so-called "selenium," with traces of organic matter; that a quantitative examination has revealed the fact that sulphur constitutes nearly one per cent. of the whole mass; and that when these impurities are eliminated the selenium appears to be more constant in its action and more sensitive to light.

FIG. 7.



Professor W. G. Adams‡ has shown that tellurium, like selenium, has its electrical resistance affected by light, and we have attempted to utilize this substance in place of selenium. The arrangement of cell (shown in Fig. 7) was constructed for this purpose in the early

* Continued from page 197.

† "Proceedings of American Association for the Advancement of Science," August 27, 1880; see, also, "American Journal of Science," vol. xx, p. 305; "Journal of the American Electrical Society," vol. iii, p. 3; "Journal of the Society of Telegraph Engineers and Electricians," vol. ix, p. 404; "Annales de Chimie et de Physique," vol. xxi.

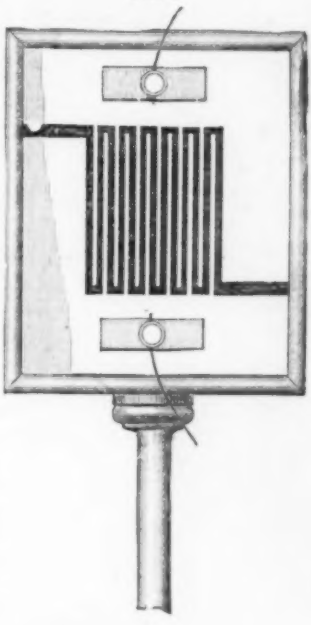
‡ "Proceedings of the Royal Society," vol. xxiv, p. 163.

part of 1880; but we failed at that time to obtain any indications of sensitiveness with a reflecting galvanometer. We have since found, however, that when this tellurium spiral is connected in circuit with a galvanic battery and telephone, and exposed to the action of an intermittent beam of sunlight, a distinct musical tone is produced by the telephone. The audible effect is much increased by placing the tellurium cell with the battery in the primary circuit of an induction-coil, and placing the telephone in the secondary circuit.

The enormously high resistance of selenium and the extremely low resistance of tellurium suggested the thought that an alloy of these two substances might possess intermediate electrical properties. We have accordingly mixed together selenium and tellurium in different proportions, and, while we do not feel warranted at the present time in making definite statements concerning the results, I may say that such alloys have proved to be sensitive to the action of light.

It occurred to Mr. Tainter, before my return to Washington last January, that the very great molecular disturbance produced in lampblack by the action of intermittent sunlight should produce a corresponding disturbance in an electric current passed through it, in which case lampblack could be employed in place of selenium in an electrical receiver. This has turned out to be the case, and the importance of the discovery is very great, especially when we consider the expense of such rare substances as selenium and tellurium.

FIG. 8.



The form of lampblack cell we have found most effective is shown in Fig. 8. Silver is deposited upon a plate of glass, and a zigzag line is then scratched through the film, as shown, dividing the silver surface into two portions insulated from one another, having the form of two combs with interlocking teeth.

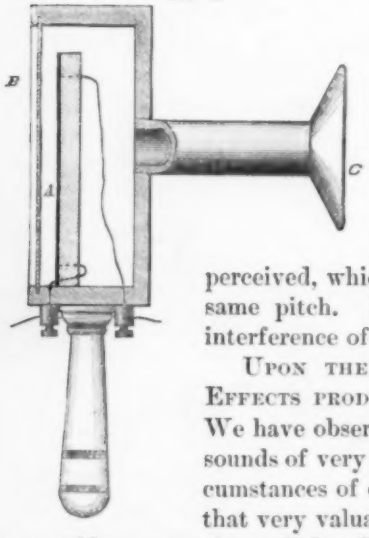
Each comb is attached to a screw-cup, so that the cell can be placed in an electrical circuit when required. The surface is then smoked until a good film of lampblack is obtained, filling the interstices between the teeth of the silver combs. When the lampblack cell is connected with a telephone and galvanic battery, and exposed to the influence of an intermittent beam of sunlight, a loud musical tone is produced by the telephone. This result seems to be due rather to the physical condition than to the nature of the conducting material employed, as metals in a spongy condition produce similar effects. For

instance, when an electrical current is passed through spongy platinum while it is exposed to intermittent sunlight, a distinct musical tone is produced by a telephone in the same circuit. In all such cases the effect is increased by the use of an induction-coil; and the sensitive cells can be employed for the reproduction of articulate speech, as well as for the production of musical sounds.

We have also found that loud sounds are produced from lampblack by passing through it an intermittent electrical current; and that it can be used as a telephonic receiver for the reproduction of articulate speech by electrical means.

A convenient mode of arranging a lampblack cell for experimental purposes is shown in Fig. 9. When an intermittent current is passed through the lampblack (A), or when an intermittent beam of sunlight falls upon it through the glass plate (B), a loud musical tone can be heard by applying the ear to the hearing-tube (C). When the light and the electrical current act simultaneously, two musical tones are perceived, which produce beats when nearly of the same pitch. By proper arrangements a complete interference of sound can undoubtedly be produced.

Fig. 9.



Upon the Measurement of the Sonorous Effects produced by Different Substances.—We have observed that different substances produce sounds of very different intensities under similar circumstances of experiment, and it has appeared to us that very valuable information might be obtained if we could measure the audible effects produced. For this purpose we have constructed several different forms of apparatus for studying the effects, but, as our researches are not yet complete, I shall confine myself to a simple description of some of the forms of apparatus we have devised.

When a beam of light is brought to a focus by means of a lens, the beam diverging from the focal point becomes weaker as the distance increases in a calculable degree. Hence, if we can determine the distances from the focal point at which two different substances emit sounds of equal intensity, we can calculate their relative sonorous powers.

Preliminary experiments were made by Mr. Tainter, during my absence in Europe, to ascertain the distance from the focal point of a lens at which the sound produced by a substance became inaudible. A few of the results obtained will show the enormous differences existing between different substances in this respect.

DISTANCE FROM FOCAL POINT OF LENS AT WHICH SOUNDS BECOME INAUDIBLE WITH DIFFERENT SUBSTANCES.

	Metres.
Zinc diaphragm (polished)	1·51
Hard-rubber diaphragm	1·90
Tin-foil "	2·00
Telephone " (japanned iron)	2·15
Zinc " (unpolished)	2·15
White silk, (in receiver shown in Fig. 1.)	3·10
White worsted, " " "	4·01
Yellow worsted, " " "	4·06
Yellow silk, " " "	4·13
White cotton-wool, " " "	4·38
Green silk, " " "	4·52
Blue worsted, " " "	4·69
Purple silk, " " "	4·82
Brown silk, " " "	5·02
Black silk, " " "	5·21
Red silk, " " "	5·24
Black worsted, " " "	6·50
Lampblack. In receiver the limit of audibility could not be determined, on account of want of space. Sound perfectly audible at a distance of	10·00

Mr. Tainter was convinced from these experiments that this field of research promised valuable results, and he at once devised an apparatus for studying the effects, which he described to me upon my return from Europe. The apparatus has since been constructed, and I take great pleasure in showing it to you to-day.

1. A beam of light is received by two similar lenses (A B, Fig. 10), which bring the light to a focus on either side of the interrupting disk (C). The two substances, whose sonorous powers are to be compared, are placed in the receiving vessels (D E) (so arranged as to expose equal surfaces to the action of the beam) which communicate, by flexible tubes (F G) of equal length, with the common hearing-tube (H). The receivers (D E) are placed upon slides, which can be moved along the graduated supports (I K). The beams of light passing through the interrupting disk (C) are alternately cut off by the swinging of a pendulum (L). Thus a musical tone is produced alternately from the substance in D and from that in E. One of the receivers is kept at a constant point upon its scale, and the other receiver is moved toward or from the focus of its beam until the ear decides that the sounds produced from D and E are of equal intensity. The relative positions of the receivers are then noted.

2. Another method of investigation is based upon the production of an interference of sound, and the apparatus employed is shown in Fig. 11. The interrupter consists of a tuning-fork (A, Fig. 11, *a*), which is kept in continuous vibration by means of an electro-magnet (B).

A powerful beam of light is brought to a focus between the prongs

of the tuning-fork (A), and the passage of the beam is more or less obstructed by the vibration of the opaque screens (C D) carried by the prongs of the fork.

As the tuning-fork (A) produces a sound by its own vibration, it is placed at a sufficient distance away to be inaudible through the air, and a system of lenses is employed for the purpose of bringing the undulating beam of light to the receiving lens (E) with as little loss as possible. The two receivers (F G) are attached to slides (H I) which move upon opposite sides of the axis of the beam, and the receivers are connected by flexible tubes of unequal length (K L) communicating with the common hearing-tube (M).

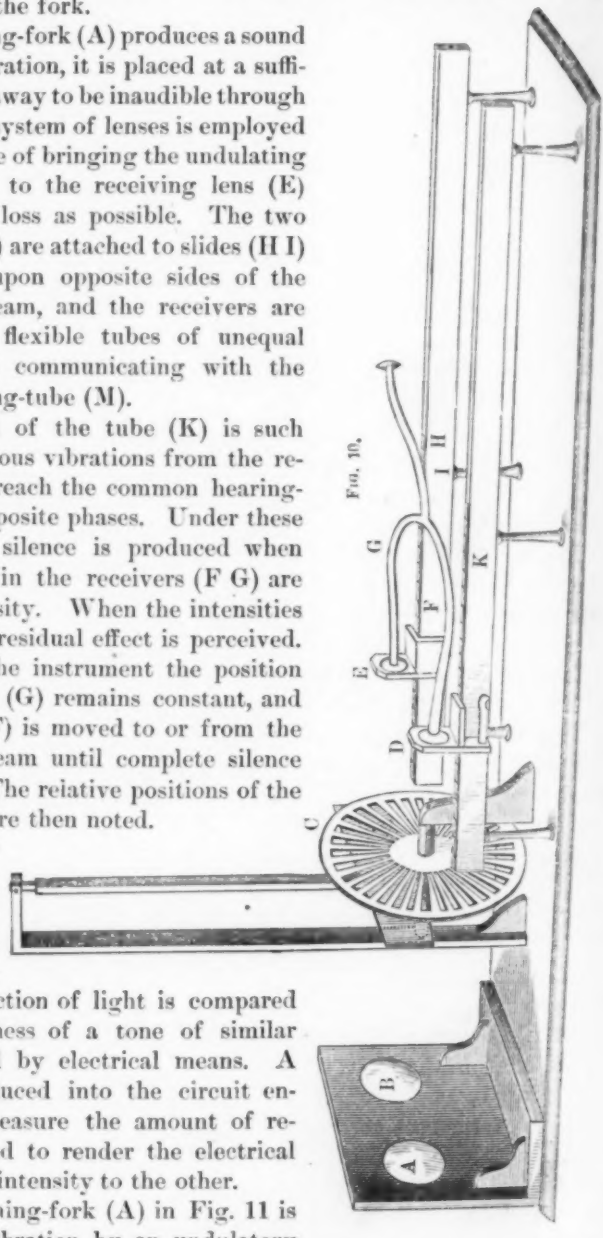


FIG. 10.

The length of the tube (K) is such that the sonorous vibrations from the receivers (F G) reach the common hearing-tube (M) in opposite phases. Under these circumstances silence is produced when the vibrations in the receivers (F G) are of equal intensity. When the intensities are unequal, a residual effect is perceived. In operating the instrument the position of the receiver (G) remains constant, and the receiver (F) is moved to or from the focus of the beam until complete silence is produced. The relative positions of the two receivers are then noted.

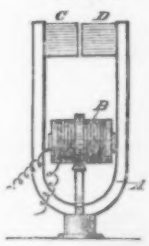
3. Another mode is as follows: The loudness of a musical tone produced by the action of light is compared with the loudness of a tone of similar pitch produced by electrical means. A rheostat introduced into the circuit enables us to measure the amount of resistance required to render the electrical sound equal in intensity to the other.

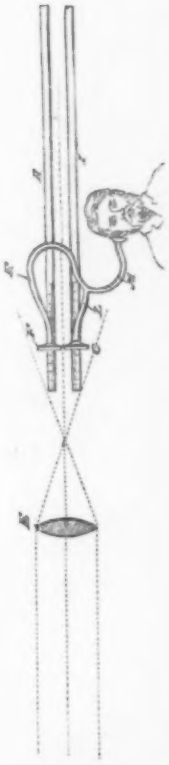
4. If the tuning-fork (A) in Fig. 11 is thrown into vibration by an undulatory instead of an intermittent current passed through the electro-magnet (B), it is probable that a musical tone, electrically produced in the re-

ceiver (F) by the action of the same current, would be found capable of extinguishing the effect produced in the receiver (G) by the action of the undulatory beam of light, in which case it should be possible to establish an acoustic balance between the effects produced by light and electricity by introducing sufficient resistance into the electric circuit.

FIG. 11.

FIG. 11, *a*.





UPON THE NATURE OF THE RAYS THAT PRODUCE SONOROUS EFFECTS IN DIFFERENT SUBSTANCES.—In my paper read before the American Association last August, and in the present paper, I have used the word "light" in its usual rather than its scientific sense, and I have not hitherto attempted to discriminate the effects produced by the different constituents of ordinary light—the thermal, luminous, and actinic rays. I find, however, that the adoption of the word "photophone" by Mr. Tainter and myself has led to the assumption that we believed the audible effects discovered by us to be due entirely to the action of luminous rays. The meaning we have uniformly attached to the words "photophone" and "light" will be obvious from the following passage, quoted from my Boston paper:

> Although effects are produced, as above shown, by forms of radiant energy, which are invisible, we have named the apparatus for the production and reproduction of sound in this way the "photophone," *because an ordinary beam of light contains the rays which are operative.*

To avoid in future any misunderstandings upon this point, we have decided to adopt the term "*radiophone*," proposed by M.

Mercadier, as a general term signifying an apparatus for the production of sound by any form of radiant energy, limiting the words *thermophone*, *photophone*, and *actinophone* to apparatus for the production of sound by thermal, luminous, or actinic rays respectively.

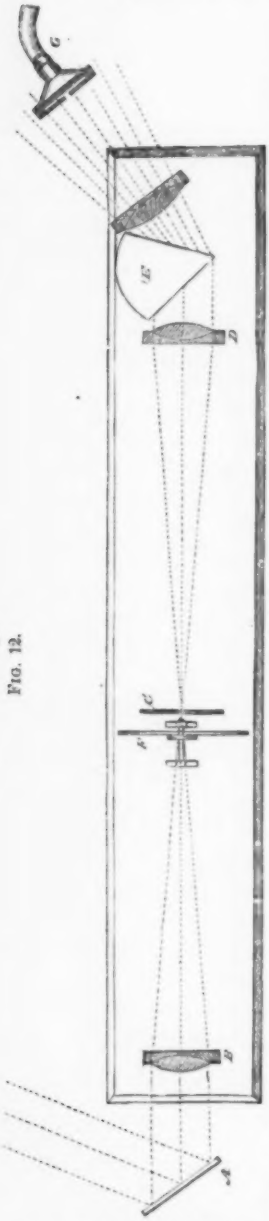


FIG. 12.

M. Mercadier, in the course of his researches in radiophony, passed an intermittent beam from an electric lamp through a prism, and then examined the audible effects produced in different parts of the spectrum ("Comptes Rendus," December 6, 1880).

We have repeated this experiment, using the sun as our source of radiation, and have obtained results somewhat different from those noted by M. Mercadier.

A beam of sunlight was reflected from a heliostat (A, Fig. 12) through an achromatic lens (B), so as to form an image of the sun upon the slit (C).

The beam then passed through another achromatic lens (D), and through a bisulphide-of-carbon prism (E), forming a spectrum of great intensity, which, when focused upon a screen, was found to be sufficiently pure to show the principal absorption lines of the solar spectrum.

The disk-interrupter (F) was then turned with sufficient rapidity to produce from five to six hundred interruptions of the light per second, and the spectrum was explored with the receiver (G), which was so arranged that the lampblack surface exposed was limited by a slit, as shown.

Under these circumstances sounds were obtained in every part of the visible spectrum, excepting the extreme half of the violet, as well as in the ultra-red. A continuous increase in the loudness of the sound was observed upon moving the receiver (G) gradually from the violet into the ultra-red. The point of maximum sound lay very far out in the ultra-red. Beyond this point the sound began to decrease, and then stopped so suddenly that a very slight motion of the receiver (G) made all the difference between almost maximum sound and complete silence.

2. The lampblacked wire gauze was then removed, and the in-

terior of the receiver (G) was filled with red worsted. Upon exploring the spectrum as before, entirely different results were obtained. The maximum effect was produced in the green at that part where the red worsted appeared to be black. On either side of this point the sound gradually died away, becoming inaudible on the one side in the middle of the indigo, and on the other at a short distance outside the edge of the red.

3. Upon substituting green silk for red worsted, the limits of audition appeared to be the middle of the blue and a point a short distance out in the ultra-red—maximum in the red.

4. Some hard-rubber shavings were now placed in the receiver (G). The limits of audibility appeared to be, on the one hand, the junction of the green and blue, and, on the other, the outside edge of the red—maximum in the yellow. Mr. Tainter thought he could hear a little way into the ultra-red, and to his ear the maximum was about the junction of the red and orange.

5. A test-tube containing the vapor of sulphuric ether was then substituted for the receiver (G). Commencing at the violet end, the test-tube was gradually moved down the spectrum and out into the ultra-red without audible effect, but, when a certain point far out in the ultra-red was reached, a distinct musical tone suddenly made its appearance, which disappeared as suddenly on moving the test-tube a very little farther on.

6. Upon exploring the spectrum with a test-tube containing the vapor of iodine, the limits of audibility appeared to be the middle of the red and the junction of the blue and indigo—maximum in the green.

7. A test-tube containing peroxide of nitrogen was substituted for that containing iodine. Distinct sounds were obtained in all parts of the visible spectrum, but no sounds were observed in the ultra-red.

The maximum effect seemed to me to be in the blue. The sounds were well marked in all parts of the violet, and I even fancied that the audible effect extended a little way into the ultra-violet, but of this I can not be certain. Upon examining the absorption spectrum of peroxide of nitrogen it was at once observed that the maximum sound was produced in that part of the spectrum where the greatest number of absorption lines made their appearance.

8. The spectrum was now explored by a selenium cell, and the audible effects were observed by means of a telephone in the same galvanic circuit with the cell. The maximum effect was produced in the red. The audible effect extended a little way into the ultra-red on the one hand and up as high as the middle of the violet on the other.

Although the experiments so far made can only be considered as preliminary to others of a more refined nature, I think we are warranted in concluding that *the nature of the rays that produce sonorous effects in different substances depends upon the nature of the substances*

that are exposed to the beam, and that the sounds are in every case due to those rays of the spectrum that are absorbed by the body.

THE SPECTROPHONE.—Our experiments upon the range of audibility of different substances in the spectrum have led us to the construction of a new instrument for use in spectrum analysis, which was described and exhibited to the Philosophical Society of Washington last Saturday.* The eye-piece of a spectroscope is removed, and sensitive substances are placed in the focal point of the instrument behind an opaque diaphragm containing a slit. These substances are put in communication with the ear by means of a hearing-tube, and thus the instrument is converted into a veritable "spectrophone," like that shown in Fig. 13.

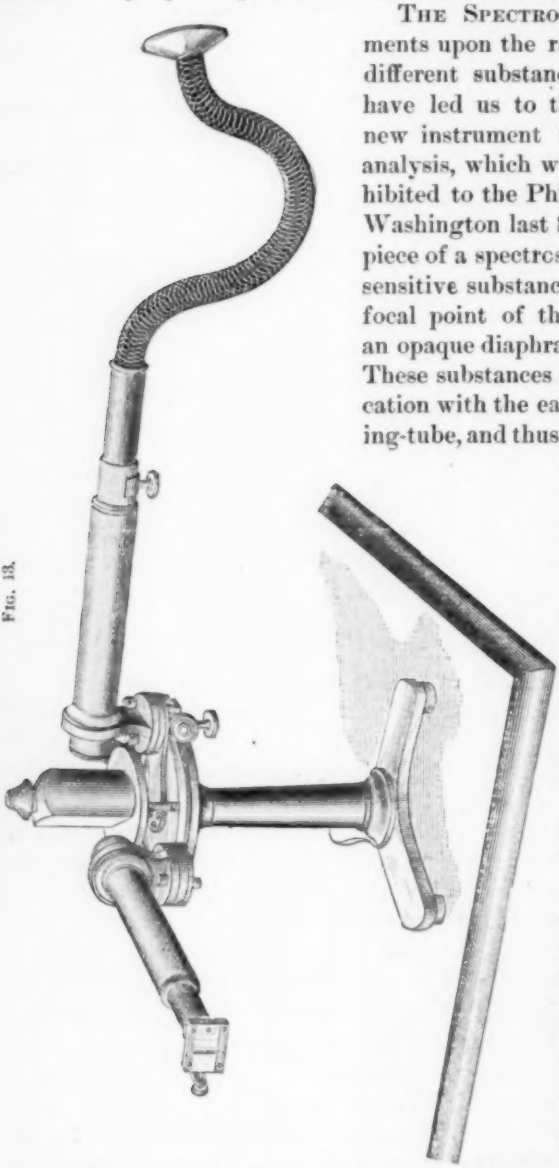


FIG. 13.

Suppose we smoke the interior of our spectrophonic receiver, and fill the cavity with peroxide of nitrogen gas. We have then a combination that gives us good sounds in all parts of the spectrum (visible and invisible), except the ultra-violet. Now, pass a rapidly-interrupted beam of light through some substance whose absorption spectrum is to be investigated, and bands of sound and silence are observed upon exploring the spectrum, the silent positions corresponding to the absorption bands. Of course, the ear can not for one moment compete with the eye in the examination of the visible part of the spectrum; but in the invisible part beyond the red, where

* "Proceedings of the Philosophical Society" of Washington, April 16, 1881.

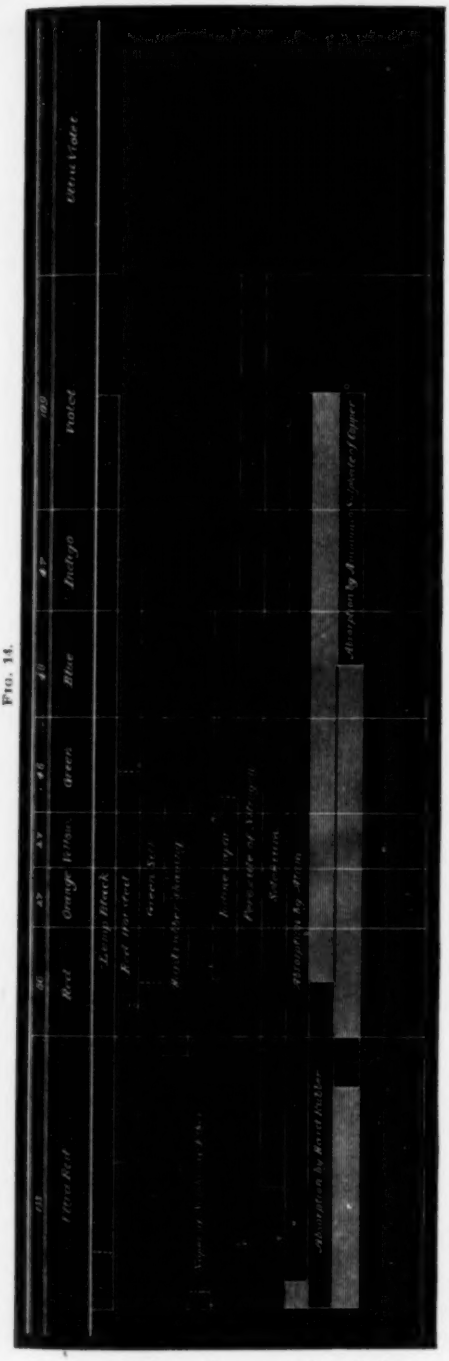


FIG. 14.

the eye is useless, the ear is invaluable. In working in this region of the spectrum, lampblack alone may be used in the spectrophonic receiver. Indeed, the sounds produced by this substance in the ultra-red are so well marked as to constitute our instrument a most reliable and convenient substitute for the thermopile. A few experiments that have been made may be interesting.

1. The interrupted beam was filtered through a saturated solution of alum.

Result: The range of audibility in the ultra-red was slightly reduced by the absorption of a narrow band of the rays of lowest refrangibility. The sounds in the visible part of the spectrum seemed to be unaffected.

2. A thin sheet of hard rubber was interposed in the path of the beam.

Result: Well-marked sounds in every part of the ultra-red. No sounds in the visible part of the spectrum, excepting the extreme half of the red.

These experiments reveal the cause of the curious fact alluded to in my paper read before the American Association last August — that sounds were heard from selenium when the beam was filtered through both hard rubber and alum at the same time. (See table of results in Fig. 14.)

3. A solution of ammonia-sulphate of copper was tried.

Result: When placed in the path of the beam, the spectrum disappeared, with the exception of the blue and violet end. To the eye the spectrum was thus reduced to a single broad band of blue-violet light. To the ear, however, the spectrum revealed itself as two bands of sound, with a broad space of silence between. The invisible rays transmitted constituted a narrow band just outside the red.

I think I have said enough to convince you of the value of this new method of examination, but I do not wish you to understand that we look upon our results as by any means complete. It is often more interesting to observe the first totterings of a child than to watch the firm tread of a full-grown man, and I feel that *our* first footsteps in this new field of science may have more of interest to you than the fuller results of mature research. This must be my excuse for having dwelt so long upon the details of incomplete experiments.

I recognize the fact that the spectrophone must ever remain a mere adjunct to the spectroscope, but I anticipate that it has a wide and independent field of usefulness in the investigation of absorption spectra in the ultra-red.

PHYSICAL EDUCATION.

By FELIX L. OSWALD, M. D.

SLEEP.

"Children, stinted in their sleep, are never wide-awake."—PESTALOZZI.

THE vital processes of man, like those of all his fellow-creatures, are partly controlled by automatic tendencies. Some functions of our internal economy are too important to be trusted to the caprices of human volition; breathing, eating, drinking, and even love, are only semi-voluntary actions; and during a period varying from one fourth to two fifths of each solar day the conscious activity of the senses undergoes a complete suspense: the cerebral workshop is closed for repairs, and the abused or exhausted body commits its organism into the healing hands of Nature. Under favorable conditions eight hours of undisturbed sleep would almost suffice to counteract the physiological mischief of the sixteen waking hours. During sleep the organ of consciousness is at rest, and the energies of the system seem to be concentrated on the function of nutrition and the renewal of the vital energy in general; sleep promotes digestion, repairs the waste of the muscular tissue, favors the process of cutaneous excretion, and renews the vigor of the mental faculties.

The amount of sleep required by man is generally proportionate to the waste of vital strength, whether by muscular exertion, mental

activity (or emotion), or by the process of rapid assimilation, as during the first years of growth and during the recovery from an exhausting disease. The weight of a new-born child increases more rapidly than that of a eupeptic adult, enjoying a liberal diet after a period of starvation, and, though an infant is incapable of forming abstract ideas, we need not doubt that the variety of new and bewildering impressions must overtask its little sensorium in a few hours. Nurslings should therefore be permitted to sleep to their full satisfaction; weakly babies, especially, need sleep more than food, and it is the safest plan never to disturb a child's slumber while the regularity of his breathing indicates the healthfulness of his repose; there is little danger of his "oversleeping" himself in a moderately warmed, well-ventilated room. Never mind about meal-times: hunger will awaken him at the right moment, or teach him to make up for lost time. Three or four nursings in the twenty-four hours are enough; Dr. C. E. Page, who has made the problem of infant diet his special study, believes that fifty per cent. of the enormous number of children dying under two years of age are killed by being coaxed to guzzle till they are hopelessly diseased with fatty degeneration.*

The healthfulness of village-children is partly due to the tranquillity of their slumber in the comfortable nooks of a quiet homestead, or in the shade of a leafy tree, while their parents are at work in a way rather incompatible with the habit of fondling the baby all night. In houses where there is plenty of room, the nursery and the infant's dormitory ought to be two separate apartments: the play-room can not be too sunny; for the bedroom a shady and sequestered location is, on the whole, preferable. Next to out-door exercise, silence and a subdued light are the best hypnotics. But under no circumstances should insomnia be overcome by cradling or narcotics. Stupefaction is not slumber. The lethargy induced by rocking and cradling is akin to the drowsy torpor of a sea-sick passenger, and the opium-doctor might as well benumb his patient by a whack on the head. The morbid sleeplessness of children may be owing to several causes which can be generally recognized by the symptoms of their *modus operandi;* impatient turning from side to side, as if in a vain attempt to obtain a much-needed repose, means that the room is too stuffy or too warm; long wakefulness, combined with squalling-fits and petulant movements, indicates acidity in the stomach (overfeeding, or too much "soothing-sirup")—let the little kicker exercise his muscle on the floor; in malignant cases, skip a meal or two, or give water instead of

* "The only wonder is that any infant lives sixty days from birth. Fed before birth but three times a day he is after birth subjected to ten or twenty meals in the twenty-four hours, until chronic dyspepsia or some acute disease interferes. . . . So far from admitting a possible error in advising three meals only, I am convinced that, for a hand-fed baby especially, two would often be better than three."—("How to feed a Baby to make it healthy and happy," p. 55.)

milk. After weathering an attack of croup, children often lie motionless on their backs with a peculiar glassy stare of their wide-open eyes. Leave them alone; instinct teaches them to assuage the distress of their lungs by slow and deep respirations; rest and a half-open window will do them more good than medicine.

Healthful infants—i. e., under rational management the great plurality—can soon be taught to transact their public business at seasonable hours, or at least to abstain from midnight serenades. If mothers would make it a rule to do all their nursing and fondling in the daytime, their little revivalists would soon learn to associate darkness with the idea of silence and slumber. Habit will do wonders in such things. Captain Barclay and several American pedestrians learned to take their half-hour naps as a traveler snatches a hasty lunch, and many old soldiers develop a faculty of going off to sleep, as it were, at the word of command, the moment their shoulders touch the guard-house bunk. The two drowsiest years of my life I passed at an old-style boarding-school, where teachers and pupils were limited to seven hours of sleep, after nine hours of study, besides written exercises and special recitations, and where sixty or seventy of us had to sleep in a large hall; and I do not believe that the last flickering of our five-minutes candle was ever witnessed by a pair of more than half-open eyes.

But that same faculty of sleeping and waking at short notice may be utilized for the purpose of taking little naps whenever opportunity offers—in the last half-hour of the noontide recess, or during the Buncombe interacts of a protracted session. The inhabitants of all intertropical countries make the time of repose a movable festival, and during the dog-days of our torrid summers it would clearly be the best plan to imitate their example. "Children must not sleep in the daytime," says a by-law of our time-dishonored Koran of domestic superstitions; and, not satisfied with keeping our little ones at school during the drowsy afternoons of the summer solstice, we increase their misery by stuffing them at the very noon of the hottest hours with a mass of greasy (i. e., heat-producing and soporific) food. An hour after the end of a long, sultry day comes the cool night-wind, heaven's own blessing for all who hunger and thirst after fresh air; but no, "Night-air is injurious"; besides, Mrs. Grundy objects to promenades after dark, so the children are driven to their suffocating, unventilated bedrooms, not to sleep but to swelter, till toward midnight, when drowsiness subsides into a sort of lethargy which yields only to broad daylight, three or four hours after sunrise; "So much the better," says the fashionable mother, who has passed the night at an ice-cream *ridotto*, "and morning air isn't healthy, either; most dangerous to leave the house before the dew is off the grass."

Only the curse of pessimism, our woful distrust of our natural instincts, can explain such absurdities. The parched palate's petition

for a cooling liquid is not plainer than the brain's craving for rest and slumber when a high temperature adds its somniferous tendency to the drowsy influence of a full meal. On warm summer days all Nature indulges in a noontide nap; I have walked through tropical forests that were as silent under the rays of a vertical sun as a Norwegian pine-grove in the dead of a polar night; nor would it be easy to name a single animal that does not appear sleepy after meals. At noon leaf-trees throw their densest shade; even butterflies seek the penetralia of the foliage, and lizards cling lazily to the dark side of the lower branches; every school-teacher knows that children feel the drowsy spell of the afternoon sun; why should they alone be hurt by yielding to its promptings? Either postpone the principal meal to the end of the day, or increase the noontide recess to at least three hours, so as to leave time for a digestive *siesta*.

In midsummer all mammals (squirrels, perhaps, excepted) become semi-nocturnal: deer and llamas pasture the moonlit mountain-meadows; bears, badgers, and the larger species of monkeys are wide-awake; buffaloes wander *en masse* to the next drinking-place; and the step-children of Nature, the starved lazzaroni of Southern Europe, forget their misery if they can procure a fiddle or a guitar. The moonlit streets of the Mexican cities swarm with merry children, but north of the Rio Grande not a decent lad is seen out-doors after sundown; Luna has to seek her Endymions in the tropics, though our summer nights are often as glorious as the *noches serenas* of southern Andalusia. And what would our hardy forefathers have said about our dread of the morning dew? How many thousands of hunters and soldiers have slept in the open fields, and how many times did we *wade* through the dew-drenched brambles of the Ardennes, my little brother and I, to see the sun rise, and breathe the mountain wind, at the only hour when the air is both fragrant and cool, inspiring thoughts which music can only awaken for a fleeting moment!—if such hours are mortiferous, there can not be a more agreeable way of ending what our latter-day epicures are pleased to call life.

What harm can there be in dividing our daily portion of sleep? Birds and beasts do it, the founders of the most ascetic orders of Spanish monks allowed it, and our summer months are certainly as warm as those of Southern Europe. People who are so anxious to improve the shining hours for business purposes had much better curtail the number of their meals; take a vote among the juvenile operatives of a cotton-factory, and ten to one that a large majority would gladly postpone, or even renounce, their dinner for the privilege of sleeping an hour or two between 1 and 3 P. M. A Belgian silk-manufacturer, who had spent his own boyhood at the loom, told me that he could never find it in his heart to discharge a factory-child for dozing over its work.

Necessity may compel individuals to compromise such matters. If

I had to work or teach all day, I would not eat a crumb between breakfast and supper, and pass the dinner-hour under a shade-tree; but parents who can afford to educate their children at home should give them either an all-summer vacation or a half-afternoon recess—let them rest from twelve till three, or sleep if they prefer; in the evening, do not send them to bed till they are really tired, and till the night-wind has revitalized the air of their bedrooms; but make them rise with the sun—if they are drowsy they will go to bed earlier the next evening. There is no danger of a child's—especially a boy's—oversleeping himself, unless the hardships of his waking hours are so intolerable that oblivion becomes a blessing; but it can do no harm to make the health-giving morning hour as attractive as possible: provide some out-door amusement, a prize foot-race, a butterfly-hunt, or gathering windfalls in the apple-orchard; if the desire for longer sleep can outweigh such inducements, there must be something wrong—plethorific diet, probably, or over-study. The requisite amount of sleep depends on temperament and occupation as well as on age; with children under ten, however, too much indulgence would be an error on the safer side: let them choose their allowance between eight and ten hours; in after-years, seven hours should be the minimum, nine the maximum for *healthy* children; sickly ones ought to have *carte blanche*, both as to quantum and time of repose; consumptives, especially, need all the rest they can get. Profound sleep in a cool, quiet retreat is Nature's own specific for all wasting diseases, a panacea without price and money.

Nothing can be more injudicious than to stint children in their sleep with a view of gaining a few hours for study. "That plan," says Pestalozzi, "defeats its own purpose, for such children are never wide-awake; you can keep them out of bed, but you can not prevent them from dozing with their eyes open. A wide-awake boy will learn more in one hour than a day-dreamer in ten."

Habitual deficiency of sleep will undermine the strongest constitution; headache, throbbing, and feverish heat are the precursors of graver evils, unless a temporary loss of mental power compels an armistice with outraged Nature. King Alfred, Spinoza, Kepler, Victor Alfieri, Madame de Staël, and Frederick Schiller killed themselves with restless study; Beethoven and Charles Dickens, too, probably prepaid the debt of Nature by their habit of fighting fatigue with strong coffee. Sleeplessness may lead to chronic hypochondria, and even to idiocy; without their long vigils, the monks of the Thebais and the fathers of the Alexandrian Church could hardly have written such stupendous nonsense. It is a curious fact that compulsory wakefulness combined with mental activity often induces a state of morbid insomnia, an absolute inability to obtain the sleep which it was at first so difficult to resist. In such cases, the only remedy is fresh air and a complete change of occupation. During sleep the brain is in a com-

paratively bloodless condition;* a hot head and throbbing temples are unfavorable to repose, and it has been suggested that insomnia might be counteracted by a hot foot-bath, chafing the arms and legs, or any similar operation that would divert the blood from the head toward the extremities, and thus tend to diminish the activity of the cerebral circulation. Listening to distant music or the ripple of a river-current has also a wonderful hypnotic effect, the repetition of monotonous sounds, or, indeed, of any sensorial impression, seems more favorable to repose than their entire absence. The philosopher Kant assures us that he could obtain sleep in a paroxysm of gout by resolutely fixing his attention on some abstruse ethical or mathematical problem, but remarks that the success of that method depends upon the laboriousness of the mental process; the mind, as it were, takes refuge in sleep as the alternative of drudging at a wearisome task. Robert Burton, too, gives a number of similar recipes, besides a list of wondrous medicinal compounds to be swallowed or inhaled *ad horam somni*, but in ordinary cases it is better to try the effects of out-door exercise, before resorting to dormouse-fat,† theological text-books, or other desperate remedies.

Being naturally a sound and long sleeper has been ranked among the surest prognostics of a long life, and sleep after a wasting disease as the most certain symptom of recovery. Most brain-workers are subject to occasional fits of insomnia, but the faculty of sustaining health and vigor upon a very small allowance of sleep is generally a concomitant of mental inferiority, or at least inactivity. The most intelligent animals, dogs and monkeys, sleep the longest; stupid brutes merely stretch their legs, their inert brain requires no rest; a cow never sleeps in the proper sense of the word. Mirabeau, Goethe, and James Quin often slumbered for twelve or fourteen hours successively, while Leopold I, of Austria, and Charles IV, of Spain, the heartless and brainless bigots, could content themselves with five hours of sleep out of the twenty-four, and their prototype, the Emperor Justinian, often even with *one*.—(Gibbon's "Rome," vol. vii, p. 406.)

Heinrich Heine wonders why Jehovah did not square his account with our wicked forefathers by punishing them in their sleep, instead of compromising their innocent progeny. Dietetic sins often avenge themselves in that way; blutwurst, sauerkraut, or short-cakes with

* Dr. Caldwell records a case of a woman at Montpellier, who "had lost part of her skull (from disease), the brain and part of its membranes lying bare. When she was in a deep and sound sleep, the brain lay in the skull almost motionless; when she was dreaming, it became elevated; and, when she awoke, it became suffused with blood and seemed inclined to rise through the cranial aperture."—("Psychological Journal," vol. v, p. 74.)

† "Anoint the soles of the feet with the fat of a dormouse, the teeth with car-wax of a dog, swine's gall, oil of nunaphar, henbane," etc.—("Correctors of Accidents to procure Sleep," "Anatomy of Melancholy," p. 414.)

pork-fritters, generally result in apocalyptic visions, and an eel-pie for supper is a reliable receipt for a first-class nightmare. Vivid dreams, *per se*, however, are by no means a morbid symptom; on the contrary, the scenes of the slumber-drama are most lively and lifelike in the happiest years of childhood; and I remember a time when I longed for the bed-hour, in anticipation of a pleasant dream-land excursion. Children are apt to relate their trance adventures, and I would encourage the habit; dreams, as the elder Pliny already observes, may often afford a suggestive insight into the ethical condition of the mind; also into the condition of the stomach. Melodramatic incidents indicate the presence of irritating ingesta, and the least attempt at clairvoyance calls for out-door exercise and an aperient diet. A South-German feather-bed is a Trophonian cave; the difficulty of turning from side to side crowds the brain with alarming phantasms, and the excessive warmth of the thing itself is apt to affect the imagination. The best bed is, indeed, a hard, broad mattress, or a well-stuffed straw tick, and, for reasons I have stated in the chapter on "In-door Life," a woolen blanket over a linen bed-sheet is preferable to a quilt. Those who find it uncomfortable to sleep in an absolutely horizontal position should slightly raise the head-end of the bedstead rather than use a thick bolster. A thick pillow bends the head upon the breast, or keeps the neck in a position that aggravates the distress of respiratory difficulties. Woven-wire mattresses recommend themselves by their cleanliness and durability; their elastic qualities alone would hardly justify a great expense, though luxury has even devised an "hydrostatic bed," a trough of water with a tegument of caoutchouc. History records the name of the Sybarite who "cried aloud because a leaflet of his flower-mattress got crumpled"; and Chevalier Luckner, the Russian Lucullus, built himself an air-pillow bed on noiseless wheels, that could be turned by a hand-lever, in order to move the sleeping-car from or toward the stove, the aphelion and perihelion being determined by the state of the out-door atmosphere. Such chevaliers deserve the penance of Ezekiel (iv, 3–6), who had to lie three hundred and ninety days on his left side for the iniquity of the house of Israel, and forty days extra for the iniquity of the house of Judah. A weary head needs no air-cushions, with noiseless wheel-attachments; brakesmen take their intermittent naps on the hard caboose-bunk of a rumbling freight-train; and the log of the Royal Sovereign records that, during the heat of the battle of the Nile, some of the over-fatigued boys fell asleep upon the deck.

The habit of going to sleep at fixed hours can overcome the tortures of neuralgia, and some practical stoics have manifested a not less astonishing command over their mental emotions; Napoleon I slept soundly on the eve of the battle he knew to be his last chance, like Mohammed II before his last neck-or-nothing assault upon the ramparts of Constantinople. Army-life can acquaint a man with

strange beds, as well as bedfellows. Skobeleff's troopers had to sleep in dug-outs on the woodless ridges of the Balkan; and during Ney's retreat from Moscow, the commander himself had once to pass a night in a root-house, where a few rotten boards and a bundle of straw formed his only protection against a raging snow-storm.

But "roughing it" teaches some useful lessons, and soldiers and hunters often learn by experience that sleep under such circumstances depends upon the possibility of *getting the feet warm;* rain in the face, or even a wet overcoat, is less anti-hypnotic than chilled toes. In a trapper's bivouac the sleepers generally lie in a circle around the camp-fire, with their feet toward the glowing embers, and the Swiss mountaineers use foot-sacks—long socks of a felt-like stuff, and wide enough to leave room for a lot of dry leaves, besides two or three pairs of stockings. Both methods are practical applications of Dr. Caldwell's theory that a decrease of the cerebral blood-circulation has a somniferous influence; in other words, that sleep can be promoted by warming the extremities of the body, and thus diverting the blood from the head.

In-doors, summer often reverses the problem; in the dog-days, when the amount of bedclothing has to be reduced to a minimum, the main point is to cool the head by lowering the temperature of the bedroom. Open windows, a hard, smooth mattress, linen bedsheets, and a light supper will generally answer the purpose; in the lower latitudes, George Combe recommends glazed brick floors, frequent sprinklings, and in very hot nights a tub with ice. And why not? The Turkish residents of Damascus pass the summer nights in the *yeyirman* or fountain-hall of their cool houses, and the garrison soldiers of San Juan d'Ulloa deem it a special privilege to sleep on the floating wharf, exposed to the spray and the fitful swell of the Gulf-tide.

In the West Indies and the Mississippi Valley, mosquito-bars are a sad necessity, but all sensible people should be glad that the French canopy-beds are going out of fashion. The French are right, though, in making children over ten years sleep alone; it is one of the rare instances of an etiquette law being supported by a valid reason. To those who can afford it, Dr. Franklin recommends even two beds per individual, and in sweltering summer nights it is certainly a blessing to be able to leave a hot bed for a cool one; in the large family guest-chambers of a German hotel, sleepless travelers can thus change the beds like relay-horses. The builders of the old English country-seats seem to have made it a rule to have the houses face due south, with few or no windows on the north side, and in such buildings the east windows would make the best bedroom fronts, both on account of the evening shade and the monitory morning sun. In our Northwestern Territories, where the thermometer ranges from 90° above zero to 45° below, it would be no bad plan to vary the location of the bedcham-

ber with the change of the season, but, as a general rule, the dormitory should be the coolest room in the house—i. e., the nearest to the north side, and the farthest from the kitchen.

THE DEVELOPMENT OF POLITICAL INSTITUTIONS.

By HERBERT SPENCER.

VIII.—CONSULTATIVE BODIES.

TWO parts of the primitive triune political structure have, in the last two chapters, been dealt with separately; or, to speak strictly, the first has been considered as independent of the second, and again, the second as independent of the first: incidentally noting its relations to the third. Here we have to treat of the two in combination. Instead of observing how from the chief, little above the rest, there is, under certain conditions, evolved the absolute ruler, entirely subordinating the select few and the many; and instead of observing how, under other conditions, the select few become an oligarchy tolerating no supreme man, and keeping the multitude in subjection, we have now to observe the cases in which there is established a coöperation between the first and the second.

After chieftainship has become settled, the chief continues to have sundry reasons for acting in concert with his head-men. It is needful to conciliate them; it is needful to get their advice and willing assistance; and, in serious matters, it is desirable to divide responsibility with them. Hence the prevalence of a consultative assembly. In Samoa, "the chief of the village and the heads of families formed, and still form, the legislative body of the place." Among the Foolahs, "before undertaking anything important or declaring war, the king [of Rabbah] is obliged to summon a council of Mallams and the principal people." Of the Mandingo states we read that, "in all affairs of importance, the king calls an assembly of the principal men, or elders, by whose counsels he is directed." And such cases might be multiplied indefinitely.

That we may fully understand the essential nature of this institution, and that we may see why, as it evolves, it assumes the distinctive characters it does, we must once more go back to the beginning.

Evidence, coming from many peoples in all times, shows that the consultative body is, at the outset, nothing more than a council of war. It is in the open-air meeting of armed men that the cluster of leaders is first seen performing that deliberative function in respect of military measures which is afterward extended to other measures. Long after

its deliberations have become more general in their scope, there survive traces of this origin.

In Rome, where the king was above all things the general, and where the senators, as the heads of clans, were, at the outset, war-chiefs, the burgesses were habitually, when called together, addressed as "spear-men": there survived the title which was naturally given to them when they were present as listeners at war-councils. So, during later days in Italy, when the small republics grew up. Describing the assembling of "citizens at the sound of a great bell, to concert together the means of their common defense," Sismondi says, "This meeting of all the men of the state capable of bearing arms was called a Parliament." Concerning the gatherings of the Poles in early times we read: "Such assemblies, before the establishment of a senate, and while the kings were limited in power, were of frequent occurrence, and . . . were attended by all who bore arms"; and at a later stage "the *comitia paludata*, which assembled during an interregnum, consisted of the whole body of nobles, who attended in the open plain, armed and equipped as if for battle." In Hungary, too, up to the beginning of the sixteenth century, "les seigneurs, à cheval et armés de pied en cap comme pour aller en guerre, se réunissaient dans le champ de courses de Rakos, près de Pesth, et là discutaient en plain air les affaires publiques." Again, "the supreme political council is the nation in arms," says Stubbs of the primitive Germans; and though, during the Merovingian period, the popular power declined, yet, "under Chlodovech and his immediate successors, the people assembled in arms had a real participation in the resolutions of the king." Even now the custom of going weapon in hand is maintained where the primitive political form remains. "To the present day," writes M. Laveleye, "the inhabitants of the Outer Rhodes of Appenzell come to the general assembly, one year at Hundwyl and the other at Trogen, each carrying in his hand an old sword or ancient rapier of the middle ages." Mr. Freeman, too, was witness to a like annual gathering in Uri, where the inhabitants assemble in arms to elect their chief magistrate and to deliberate.

It may, indeed, be alleged that in early, unsettled times the carrying of arms by each freeman was needful for personal safety, especially when a place of meeting very far from his home had to be reached. But there is evidence that, though this continued to be a cause for assembling in arms, it was not by itself a sufficient cause. While we read of the ancient Scandinavians that "all freemen capable of bearing arms were admitted" to the national assembly, and that, after his election from "among the descendants of the sacred stock," "the new sovereign was elevated amid the clash of arms and the shouts of the multitude," we also read that "nobody, not even the king or his champions, were allowed to come armed to the assizes."

Even apart from such evidence, there is ample reason to infer that the council of war originated the consultative body, and gave outlines to its structure. Defense against enemies was everywhere the need which originally prompted joint deliberation. For other purposes individual action, or action in small parties, might suffice; but for insuring the general safety combined action of the whole horde or tribe was necessary; and to secure this combined action must have been the first motive for a political gathering. Moreover, certain constitutional traits of early assemblies, among the civilized, point to councils of war as having initiated them. If we ask what must happen when, in a tribe, the predominant few debate military measures in presence of the many, the reply is that, in the absence of a developed political organization, the assent of the many to any decision must be obtained before it can be acted upon; and the like must at first happen when many tribes are united. As Gibbon says of the Diet of the Tartars, formed of chiefs of tribes and their martial trains, "the monarch who reviews the strength, must consult the inclination, of an armed people." Even if, under such conditions, the predominant few could impose their will upon the many, armed like themselves, it would clearly be impolitic to do so, since success in war would be endangered by dissension. Hence would arise the usage of putting to the surrounding mass of armed men the question whether they agreed to the course which the council of chiefs had decided upon. There would grow up a form such as that which had become established for governmental purposes at large among the early Romans, whose king or general asked the assembled burgesses or "spear-men" whether they approved of the proposal made; or like that ascribed by Tacitus to the primitive Germans, who, now with murmurs and now with brandishing of spears, rejected or accepted the suggestions of their leaders. Moreover, there would naturally come just that restricted expression of popular opinion which we are told of. The Roman burgesses were allowed to answer only "Yes" or "No" to any question put to them; and this is exactly the simple answer which the chief and head warriors would require from the rest of the warriors when war or peace had to be determined upon. A kindred restriction existed among the Spartans. In addition to the senate and coördinate kings, there was "an Ekklesia, or public assembly of citizens, convened for the purpose of approving or rejecting propositions submitted to them, with little or no liberty of discussion"—a usage quite explicable if we assume that in the Homeric Agora, from which the Spartan constitution descended, the assembled chiefs had to gain the assent of their surrounding followers before important actions could be undertaken.

Concluding, then, that war originates political deliberation, and that the select body which especially carries on this deliberation first takes shape on occasions when the public safety has to be provided

for, we shall be prepared the better to understand the traits which characterize the consultative body in later stages of its development.

Already we have seen that at the outset the militant class was of necessity the land-owning class. In the savage tribe there are no owners of the tract occupied, save the warriors who use it in common for hunting. During pastoral life, good regions for cattle-feeding are jointly held against intruders by force of arms. And, where the agricultural stage has been reached, communal possession, family possession, and individual possession, have from time to time to be defended by the sword. Hence, as was shown, the fact that in early stages the bearing of arms and the holding of land habitually go together.

While, as among hunting-peoples, land continues to be held in common, the contrasts which arise between the few and the many are such only as result from actual or supposed personal superiority of one kind or other. It is true that, as pointed out, differences of wealth, in the shape of chattels, boats, slaves, etc., cause some class-differentiations; and that thus, even before private land-owning begins, quantity of possessions aids in distinguishing the governing from the governed. When the pastoral state is arrived at and the patriarchal type established, such ownership as there is vests in the eldest son of the eldest; or if, as Sir Henry Maine says, he is to be considered trustee for the group, still his trusteeship joins with his military headship in giving him supremacy. At a later stage, when lands come to be occupied by settled families and communities, and land-ownership gains definiteness, this union of traits in each head of a group becomes more marked; and, as was shown when treating of the differentiation of nobles from freemen, several influences conspire to give the eldest son of the eldest superiority in extent of landed possessions, as well as in degree of power. Nor is this fundamental relation changed when a nobility of service replaces a nobility of birth, and when, as presently happens, the adherents of a conquering invader are rewarded by portions of the subjugated territory, granted on condition of continued military service. Throughout, the tendency continues to be for the class of military superiors to be identical with the class of large land-owners.

It follows, then, that, beginning with the general assemblage of armed freemen, all of them holding land individually or in groups, whose council of leaders, deliberating in presence of the rest, are distinguished only as being the most capable warriors, there will, through frequent wars and progressing consolidations, be produced a state in which this council of leaders becomes further distinguished from the rest by the larger possessions, and consequent greater powers, of its members. Becoming more and more contrasted with the general mass of armed freemen, the consultative body will tend gradually to subordinate it, and, eventually separating itself, will become independent.

The growth of this temporary council of war, in which the king, acting as general, summons to give their advice the leaders of his forces, into the permanent consultative body in which the king, in his capacity of ruler, presides over the deliberations of the same men on public affairs at large, is exemplified in various parts of the world. The consultative body is everywhere composed of minor chiefs, or heads of clans, or feudal lords, in whom the military and civil rule of local groups is habitually joined with wide possessions; and the examples frequently exhibit this composition on both a small and a large scale—both locally and generally. A rude and early form of the arrangement is shown in Africa. Among the Caffres "every chief chooses from among his most wealthy subjects five or six, who act as counselors to him. . . . The great council of the king is composed of the chiefs of particular kraals." A Bechuana tribe "generally includes a number of towns or villages, each having its distinct head, under whom there are a number of subordinate chiefs," who "all acknowledge the supremacy of the principal one. His power, though very great and in some instances despotic, is, nevertheless, controlled by the minor chiefs, who, in their *pichos* or *pitshos*, their parliament or public meetings, use the greatest plainness of speech in exposing what they consider culpable or lax in his government." Of the Wanyamwezi, Burton says that the Sultan is "surrounded by a council, varying from two to a score of chiefs and elders. . . . His authority is circumscribed by a rude balance of power; the chiefs around him can probably bring as many warriors into the field as he can." Similarly in Ashantee. "The caboceers and captains . . . claim to be heard on all questions relating to war and foreign politics. Such matters are considered in a general assembly, and the king sometimes finds it prudent to yield to the views and urgent representations of the majority." From the ancient American states, too, instances may be cited. In Mexico "general assemblies were presided over by the king every eighty days. They came to these meetings from all parts of the country"; and then we read further that the highest rank of nobility, the Teuctli, "took precedence of all others in the senate, both in the order of sitting and voting," showing what was the composition of the senate. It was so, too, with the Central Americans of Vera Paz: "Though the supreme rule was exercised by a king, there were inferior lords as his coadjutors, who mostly were titled lords and vassals; they formed the royal council, . . . and joined the king in his palace as often as they were called upon." Turning to Europe, mention may first be made of ancient Poland. Originally formed of independent tribes, "each governed by its own *kniaz*, or judge, whom age or reputed wisdom had raised to that dignity," and each led in war by a temporary *voivod* or captain, these tribes had, in the course of that compounding and recompounding which wars produced, differentiated into classes of nobles and serfs, over whom was an elected king. Of the organi-

zation which existed before the king lost his power, we are told that—

> Though each of these palatines, bishops, and barons, could thus advise his sovereign, the formation of a regular senate was slow, and completed only when experience had proved its utility. At first, the only subjects on which the monarch deliberated with his barons related to war; what he originally granted through courtesy, or through diffidence in himself, or with a view to lessen his responsibility in case of failure, *they* eventually claimed as a right.

So, too, during internal wars and wars against Rome, the primitive Germanic tribes, once semi-nomadic and but slightly organized, passing through the stage in which armed chiefs and freemen periodically assembled for deliberations on war and other matters, evolved a kindred structure. In Charlemagne's time, at the great assembly of the year—

> The dukes, counts, bishops, scabini, and centenaries—all who were connected with the government or the administration—were officially present; the great and small proprietors, the barons and gentry, were so in virtue of their fiefs, the freemen in virtue of their character as warriors, though undoubtedly there were few freemen obliged to bear arms not provided with some portion of landed property.

And then at a later period, as Hallam writes—

> In all the German principalities a form of limited monarchy prevailed, reflecting, on a reduced scale, the general constitution of the empire. As the emperors shared their legislative sovereignty with the Diet, so all the princes who belonged to that assembly had their own provincial states, composed of their feudal vassals and of their mediate towns within their territory—

the mass of the rural population having thus ceased to possess power. Similarly during the later feudal period in France. An "ordinance of 1228, respecting the heretics of Languedoc, is rendered with the advice of our great men and prudhommes"; and one "of 1246, concerning levies and redemptions in Anjou and Maine," says that, "having called around us, at Orleans, the barons and great men of the said counties, and having held attentive counsel with them," etc.

To meet the probable criticism that no notice has been taken of the ecclesiastics usually included in the consultative body, it is needful to point out that due recognition of them does not involve any essential change in the account above given. Though modern usages lead us to think of the priest-class as distinct from the warrior-class, yet it was not originally distinct. With the truth that, habitually in militant societies, the king is at once commander-in-chief and high-priest, carrying out in both capacities the dictates of his deity, we may join the truth that the subordinate priest is usually a direct or indirect aider of the wars thus supposed to be divinely prompted. In illustration of the one truth may be cited the fact that, before going to war, Radama, King of Madagascar, "acting as priest as well as general, sacrificed a

cock and a heifer, and offered a prayer at the tomb of Andria-Masina, his most renowned ancestor." And in illustration of the other truth may be cited the fact that, among the Hebrews, whose priests accompanied the army to battle, we read of Samuel, a priest from childhood upward, as conveying to Saul God's command to "smite Amalek," and as having himself hewed Agag in pieces. More or less active participation in war by priests we everywhere find in savage and semi-civilized societies; as among the Dakotas, Mundrucus, Abipones, Khonds, whose priests decide on the time for war, or give the signal for attack; as among the Tahitians, whose priests "bore arms, and marched with the warriors to battle"; as among the Mexicans, whose priests, the habitual instigators of wars, accompanied their idols in front of the army, and "sacrificed the first-taken prisoners" at once; as among the ancient Egyptians, of whom we read that "the priest of a god was often a military or naval commander." And the naturalness of the connection, thus common in rude and in ancient societies, is shown by its revival in later societies, notwithstanding an adverse creed. After Christianity had passed out of its early extra-political stage into the stage in which it became a state religion, its priests, during actively militant periods, reacquired the primitive militant character. "By the middle of the eighth century [in France], regular military service on the part of the clergy was already fully developed." In the early feudal period, bishops, abbots, and priors, became feudal lords, with all the powers and responsibilities attaching to their positions: they had bodies of troops in their pay, took towns and fortresses, sustained sieges, led or sent troops in aid of kings. And Orderic, in 1094, describes the priests as leading their parishioners to battle, and the abbots their vassals. Though in recent times Church dignitaries do not actively participate in war, yet their advisatory function respecting it —often prompting rather than restraining—has not even now ceased, as among ourselves was lately shown in the vote of the bishops, who, with one exception, approved the invasion of Afghanistan.

That the consultative body habitually includes ecclesiastics, does not, therefore, conflict with the statement that, beginning as a war-council, it grows into a permanent assembly of minor military heads.

Under a different form there is here partially repeated what was set forth when treating of oligarchies: the difference arising from inclusion of the king as a coöperative factor. Moreover, much that was before said respecting the influence of war in narrowing oligarchies applies to that narrowing of the primitive consultative assembly by which there is produced from it a body of land-owning military nobles. But that consolidation of small societies into large ones effected by war brings other influences which join in working this result.

In early assemblies of men similarly armed it must happen that though the inferior many will recognize that authority of the superior

few which is due to their leaderships as warriors, to their clan-headships, or to their supposed supernatural descent, yet the superior few, conscious that they are no match for the inferior many in a physical contest, will be obliged to treat their opinions with some deference—will not be able completely to monopolize power. But as fast as there progresses that class-differentiation before described, and as fast as the superior few acquire better weapons than the inferior many, or, as among various ancient peoples, have war-chariots, or, as in mediæval Europe, wear coats of mail or plate-armor and are mounted on horses, they, feeling their advantage, will pay less respect to the opinions of the many. And the habit of ignoring their opinions will be followed by the habit of regarding any expression of their opinions as an impertinence.

This gradual usurpation will be furthered by the growth of those bodies of armed dependents with which the superior few surround themselves—mercenaries and others, who, while unconnected with the common freemen, are bound by fealty to their employers. These, too, with better weapons and defensive appliances than the mass, will be led to regard them with contempt, and to aid in subordinating them.

Not only on the occasions of general assemblies, but from day to day in their respective localities, the increasing power of the chiefs thus caused will tend to reduce the freemen more and more to the rank of dependents, and especially so where the military service of such nobles to their king is dispensed with or allowed to lapse, as happened in Denmark about the thirteenth century:

> The free peasantry, who were originally independent proprietors of the soil, and had an equal suffrage with the highest nobles in the land, were thus compelled to seek the protection of these powerful lords, and to come under vassalage to some neighboring Herremand or bishop or convent. The provincial diets, or Lands-Ting, were gradually superseded by the general national Parliament of the Dannehof, Adel-Ting, or Herredag; the latter being exclusively composed of the princes, prelates, and other great men of the kingdom. . . . As the influence of the peasantry had declined, while the burghers did not yet enjoy any share of political power, the constitution, although disjointed and fluctuating, was rapidly approaching the form it ultimately assumed—that of a feudal and sacerdotal oligarchy.

A further influence conducing to loss of power by the armed freemen and gain of power by the armed chiefs, who form the consultative body, follows that widening of the occupied area which goes along with the compounding and recompounding of societies. As Richter remarks of the Merovingian period: "Under Chlodovech and his immediate successors, the people assembled in arms had a real participation in the resolutions of the king. But, with the increasing size of the kingdom, the meeting of the entire people became impossible." Only those who lived near the appointed places could attend. Two

facts, one already given under another head, may be named as illustrating this effect: "The greatest national council in Madagascar is an assembly of the people of the capital and the heads of the provinces, districts, towns, villages," etc.; and, speaking of the English Witenagemot, Mr. Freeman says, "Sometimes we find direct mention of the presence of large and popular classes of men, as the citizens of London or Winchester": the implication in both cases being that all freemen had a right to attend, but that only those on the spot could readily avail themselves of the right. This cause for restriction, which is commented upon by Mr. Freeman, operates in several ways. The actual cost of a journey to the place fixed for the meeting, when a kingdom has become large, is too great to be borne by a man who owns but a few acres. Further, there is the indirect cost entailed by loss of time, which, to one who personally labors or superintends labor, is serious. Again, there is the danger, which in turbulent times is considerable, save to those who go with bodies of well-armed retainers. And obviously these deterrent causes must tell where, for the above reasons, the incentives to attend have become small.

Yet another cause coöperates. When the occupied area is large, and therefore the number inhabiting it great, an assembly of all the armed freemen, could they be gathered, would be disabled from taking part in the proceedings, both by its size and by its lack of organization. A multitude made of those who have come from scattered points over a wide country, mostly unknown to one another, unable to hold previous communication, and therefore without plans, as well as without leaders, can not cope with the relatively small but well-organized body of those having common ideas and acting in concert.

Nor should there be omitted the fact that when the causes above named have conspired to decrease the attendance of men in arms who live far off, and when there grows up the usage of summoning the more important among them, it naturally happens that in course of time the receipt of a summons becomes the authority for attendance, and the absence of a summons becomes equivalent to the absence of a right to attend.

Here, then, are several influences, all directly or indirectly consequent upon war, which join in differentiating the consultative body from the mass of armed freemen out of which it arises.

Given the ruler, and given the consultative body thus arising, there remains to ask, What are the causes of change in their relative powers? Always between these two authorities there must be a struggle—each trying to subordinate the other. Under what conditions, then, is the king enabled to override the consultative body; and under what conditions is the consultative body enabled to override the king?

Inevitably a belief in the superhuman nature of the king gives him an immense advantage in the contest for supremacy. If he is god-

descended, open opposition to his will by his advisers is out of the question; and members of his council, singly or in combination, dare do no more than tender humble advice. Moreover, if the line of succession is so settled that there rarely or never occur occasions on which the king has to be elected by the chief men, so that they have no opportunity of choosing one who will conform to their wishes, they are further debarred from maintaining any authority. Hence, habitually, we do not find consultative bodies having an independent *status* in the despotically governed countries of the East, ancient or modern. Though we read of the Egyptian king that "he appears to have been attended in war by the council of the thirty, composed apparently of privy councilors, scribes, and high officers of state," the implication is that the members of this council were functionaries, having such powers only as the king deputed to them. Similarly in Babylonia and Assyria, attendants and others who performed the duties of ministers and advisers to the god-descended rulers did not form established assemblies for deliberative purposes. In ancient Persia, too, there was a like condition. The hereditary king, almost sacred and bearing extravagant titles, though subject to some check from princes and nobles of royal blood who were leaders of the army, and who tendered advice, was not under the restraint of a constituted body of them. Throughout the history of Japan down to our own time a kindred state of things existed. The Daimios were required to be present at the capital during prescribed intervals, as a precaution against insubordination; but they were never, while there, called together to take any share in the government. And hereditary divine kingship, having this as its concomitant in Japan, has it likewise in China. We read that, "although there is nominally no deliberative or advisatory body in the Chinese Government, and nothing really analogous to a congress, parliament, or *tiers-état*, still necessity compels the Emperor to consult and advise with some of his officers." Nor does Europe fail to yield us evidence of like meaning. I do not refer only to the case of Russia, but more especially to the case of France during the time when monarchy had assumed its most absolute form. In the age when divines like Bossuet taught that "the King is accountable to no one, . . . the whole state is in him, and the will of the whole people is contained in his"—in the age when the King (Louis XIV), "imbued with the idea of his omnipotence and divine mission," "was regarded by his subjects with adoration"—he "had extinguished and absorbed even the minutest trace, idea, and recollection of all other authority except that which emanated from himself alone." Along with establishment of hereditary succession and acquirement of divine *prestige*, such power of the other estates as existed in early days had disappeared.

Conversely, there are cases showing that where the king has never had, or does not preserve, the *prestige* of supposed descent from a

god, and where he continues to be elective, the power of the consultative body is apt to override the royal power, and eventually to suppress it. The first to be named is that of Rome. Originally "the king convoked the senate when he pleased, and laid before it his questions; no senator might declare his opinion unasked; still less might the senate meet without being summoned." But here, where the king, though regarded as having divine approval, was not held to be of divine descent, and where, though usually nominated by a predecessor, he was sometimes practically elected by the senate and always submitted to the form of popular approval, the consultative body presently became supreme. "The senate had in course of time been converted, from a corporation intended merely to advise the magistrates, into a board commanding the magistrates, and self-governing." Afterward "the right of nominating and canceling senators, originally belonging to the magistrates, was withdrawn from them"; and, finally, "the irremovable character and life-tenure of the members of the ruling order, who obtained seat and vote, was definitely consolidated": the oligarchic constitution became pronounced. The history of Poland yields another example. After unions of simply-governed tribes had produced small states and generated a nobility, and after these small states had been united, there arose a kingship. At first elective, as kingships habitually are, this continued so—never became hereditary. On the occasion of each election out of the royal clan, there was an opportunity of choosing for king one whose character the turbulent nobles thought fittest for their own purposes; and hence it resulted that the power of the kingship decayed. Eventually—

> Of the three orders into which the state was divided, the king, though his authority had been anciently despotic, was the least important. His dignity was unaccompanied with power; he was merely the president of the senate, and the chief judge of the republic.

And then there is the instance furnished by Scandinavia, already named in another relation. Danish, Norwegian, and Swedish kings were originally elective; and, though, on sundry occasions, hereditary succession became for a time the usage, there were repeated lapses into the elective form, with the result that predominance was gained by the feudal chieftains and prelates forming the consultative body.

The second element in the triune political structure is thus, like the first, developed by militancy. By this the ruler is eventually separated from all below him; and by this the superior few become integrated into a deliberative body separated from the inferior many.

That the council of war, formed of leading warriors who debate in presence of their followers, is the germ out of which the consultative body arises, is implied by the survival of usages which show that a political gathering is originally a gathering of armed men. In har-

mony with this implication are such facts as that, after a comparatively settled state has been reached, the power of the assembled people is limited to accepting or rejecting the proposals made, and that the members of the consultative body, summoned by the ruler, who is also the general, give their opinions only when invited by him to do so.

Nor do we lack clews to the process by which the primitive war-council grows, consolidates, and separates itself. Within the warrior-class, which is also the land-owning class, war produces increasing differences of wealth, as well as increasing differences of *status;* so that, along with the compounding and recompounding of groups which war brings about, the military leaders come to be distinguished as large land-owners and local rulers. Hence, members of the consultative body become contrasted with the freemen at large, not only as leading warriors are contrasted with their followers, but, still more, as men of wealth and authority.

This increasing contrast between the second and third elements of the triune political body ends in separation when, in course of time, war consolidates large territories. Armed freemen scattered over a wide area are deterred from attending the periodic assemblies by cost of travel, by cost of time, by danger, and also by the experience that multitudes of men, unprepared and unorganized, are helpless in presence of an organized few, better armed and mounted, and with bands of retainers. So that, passing through a time during which only the armed freemen living near the place of meeting attend, there comes a time when even these, not being summoned, are considered as having no right to attend; and thus the consultative body becomes completely differentiated.

Changes in the relative powers of the ruler and the consultative body are determined by obvious causes. If the king retains or acquires the repute of supernatural origin or authority, and the law of hereditary succession is so settled as to exclude election, those who might else have formed a consultative body having coördinate power become simply appointed advisers. But, if the king has not the *prestige* of supposed sacred origin or commission, and continues to be elective, then the consultative body retains power, and is liable to become an oligarchy.

Of course, it is not alleged that all consultative bodies have arisen in the way described, or are constituted in like manner. Societies, broken up by wars or dissolved by revolutions, may preserve so little of their primitive organizations that there remain no classes of the kinds out of which such consultative bodies as those described arise. Or, as we see in our own colonies, societies may have been formed in ways which have not fostered classes of land-owning militant chiefs, and therefore do not furnish the elements out of which the consultative body, in its primitive shape, is composed. Under conditions of

these kinds the assemblies answering to them, so far as may be in position and function, are formed under the influence of tradition or example; and in default of men of the original kind are formed of others—generally, however, of those who, by position, seniority, or previous official experience, are more eminent than those forming popular assemblies. It is only to what may be called the normal consultative body which grows up during that compounding and recompounding of small societies into large ones which war effects that the foregoing description applies; and the senates, or superior chambers, which arise under later and more complex conditions, may be considered as homologous to them in function and composition so far only as the new conditions permit.

ON FRUITS AND SEEDS.*

By Sir JOHN LUBBOCK, F. R. S.

IN a very large number of cases the diffusion of seeds is effected by animals. To this class belong the fruits and berries. In them an outer fleshy portion becomes pulpy, and generally sweet, inclosing the seeds. It is remarkable that such fruits, in order, doubtless, to attract animals, are, like flowers, brightly colored—as, for instance, the cherry, currant, apple, peach, plum, strawberry, raspberry, and many others. This color, moreover, is not present in the unripe fruit, but is rapidly developed at maturity. In such cases the actual seed is generally protected by a dense, sometimes almost stony, covering, so that it escapes digestion, while its germination is perhaps hastened by the heat of the animal's body. It may be said that the skin of apple and pear pips is comparatively soft; but then they are imbedded in a stringy core, which is seldom eaten.

These colored fruits form a considerable part of the food of monkeys in the tropical regions of the earth, and we can, I think, hardly doubt that these animals are guided by the colors, just as we are, in selecting the ripe fruit. This has a curious bearing on an interesting question as to the power of distinguishing color possessed by our ancestors in bygone times. Magnus and Geiger, relying on the well-known fact that the ancient languages are poor in words for color, and that in the oldest books—as, for instance, in the Vedas, the Zend-Avesta, the Old Testament, and the writings of Homer and Hesiod—though, of course, the heavens are referred to over and over again, its blue color is never dwelt on, have argued that the ancients were very deficient in the power of distinguishing colors, and especially blue. In our own country Mr. Gladstone has lent the weight of his great

* Continued from page 171.

authority to the same conclusion. For my part I can not accept this view. There are, it seems to me, very strong reasons against it, into which I can not, of course, now enter; and, though I should rely mainly on other considerations, the colors of fruits are not, I think, without significance. If monkeys and apes could distinguish them, surely we may infer that even the most savage of men could do so too. Zeuxis would never have deceived the birds if he had not had a fair perception of color.

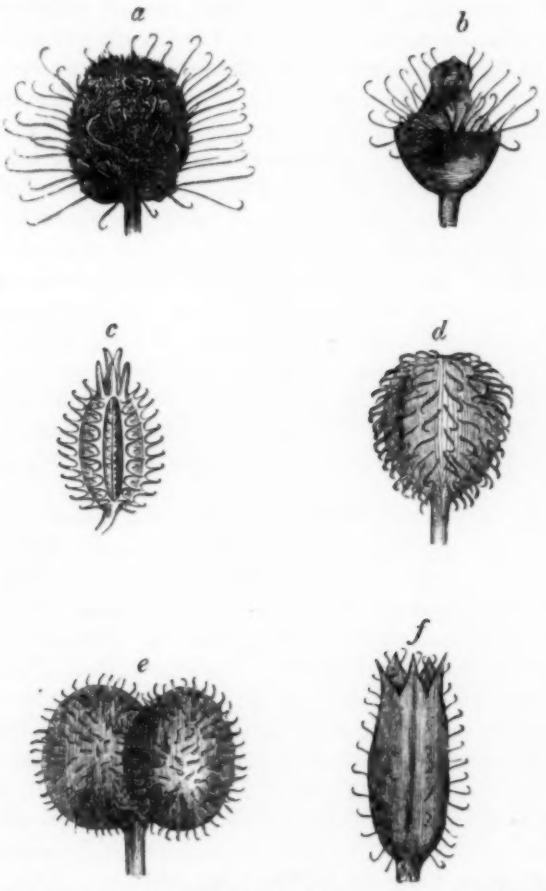


FIG. 14.—*a*, burdock (*Lappa*); *b*, agrimony (*Agrimonia*); *c*, bur parsley (*Caucalis*); *d*, enchanter's nightshade (*Circæa*); *e*, cleavers (*Galium*); *f*, forget-me-nots (*Myosotis*).

In these instances of colored fruits, the fleshy edible part more or less surrounds the true seeds; in others the actual seeds themselves become edible. In the former the edible part serves as a temptation to animals; in the latter it is stored up for the use of the plant itself. When, therefore, the seeds themselves are edible they are generally protected by more or less hard or bitter envelopes, for instance the

horse-chestnut, beech, Spanish chestnut, walnut, etc. That these seeds are used as food by squirrels and other animals is, however, by no means necessarily an evil to the plant, for the result is that they are often carried some distance and then dropped, or stored up and forgotten, so that in this way they get carried away from the parent tree.

In another class of instances animals, unconsciously or unwillingly, serve in the dispersion of seeds. These cases may be divided into two classes, those in which the fruits are provided with hooks, and those in which they are sticky. To the first class belong, among our common English plants, the burdock (*Lappa*, Fig. 14 *a*), agrimony (*Agrimonia*, Fig. 14 *b*); the bur parsley (*Caucalis*, Fig. 14 *c*); enchanter's nightshade (*Circæa*, Fig. 14 *d*); goose-grass or cleavers (*Galium*, Fig. 14 *e*), and some of the forget-me-nots (*Myosotis*, Fig. 14 *f*). The hooks, moreover, are so arranged as to promote the removal of the fruits. In all these species the hooks, though beautifully formed, are small; but in some foreign species they become truly formidable. Two of the most remarkable are represented on page 357—*Martynia proboscidea* (Fig. 15 *b*) and *Harpagophyton procumbens* (Fig. 15 *a*). Martynia is a plant of Louisiana, and if its fruits once get hold of an animal it is most difficult to remove them. Harpagophytum is a South African genus. The fruits are most formidable, and are said sometimes even to kill lions. They roll about over the dry plains, and, if they attach themselves to the skin, the wretched animal tries to tear them out, and sometimes getting them into his mouth perishes miserably.

The cases in which the diffusion of fruits and seeds is affected by their being sticky are less numerous, and we have no well-marked instance among our native plants. The common plumbago of South Europe is a case which many of you no doubt have observed. Other genera with the same mode of dispersion are *Pittosporum*, *Pisonia*, *Boerhavia Siegesbeckia*, *Grindelia*, *Drymaria*, etc. There are comparatively few cases in which the same plant uses more than one of these modes of promoting the dispersion of its seeds, still there are some such instances. Thus in the common burdock the seeds have a pappus, while the whole flower-head is provided with hooks which readily attach themselves to any passing animal. *Asterothrix*, as Hildebrand has pointed out, has three provisions for dispersion; it has a hollow appendage, a pappus, and a rough surface.

But perhaps it will be said that I have picked out special cases; that others could have been selected, which would not bear out, or perhaps would even negative, the inferences which have been indicated; that I have put the cart before the horse; that the ash-fruit has not a wing in order that it may be carried by the wind, or the burdock hooks that the heads may be transported by animals, but that, happening to have wings and hooks, these seeds are thus transported. Now, doubtless there are many points connected with seeds

which are still unexplained; in fact, it is because this is so that I was anxious to direct attention to the subject. Still I believe the general explanations which have been given by botanists will stand any test.

Let us take, for instance, seeds formed on the same type as that of the ash—heavy fruits, with a long wing, known to botanists as a *samara*. Now, such a fruit would be of little use to low herbs, which, however, are so numerous. If the wing was accidental, if it was not developed to serve as a means of dispersion, it would be as likely to occur on low plants and shrubs as on trees. Let us, then, consider on what kind of plants these fruits are found. They occur on the ash, maple, sycamore, hornbeam, pines, firs, and elm; while the lime, as

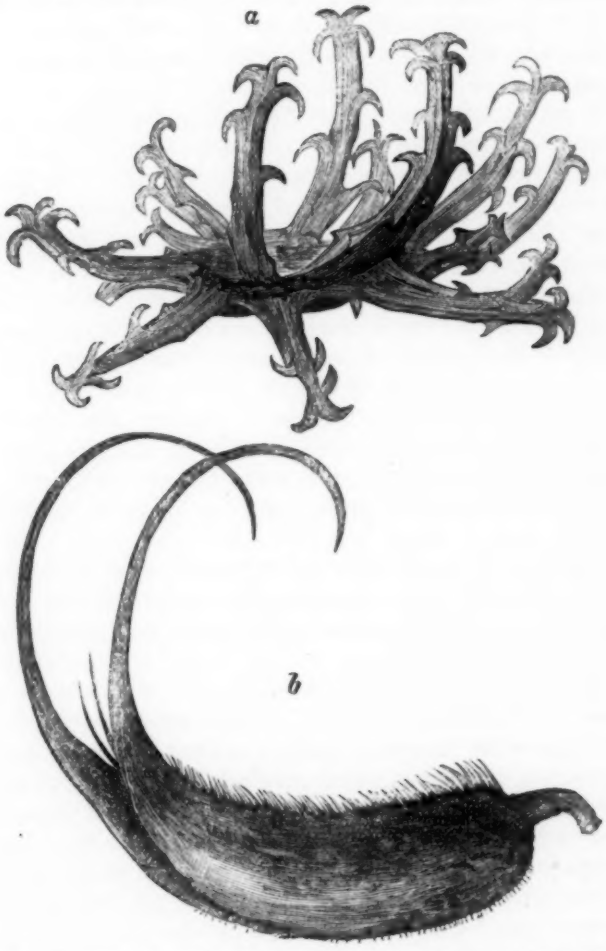


FIG. 15.—*a*, HARPAGOPHYTON PROCUMBENS (natural size); *b*, MARTYNIA PROBOSCIDEA (natural size).

we have seen, has also a leaf attached to the fruits, which answers the same purposes. Seeds of this character therefore occur on a large proportion of our forest-trees, and on them alone. But more than this: I have taken one or two of the most accessible works in which seeds are figured, for instance, Gärtner's "De Fructibus et Seminibus," Le Maout and Decaisne's (Hooker's translation) "Descriptive and Analytical Botany," and Baillon's "Histoire des Plantes." I find thirty genera, belonging to twenty-one different natural orders, figured as having seeds or fruits of this form. They are all trees or climbing shrubs, not one being a low herb.

Let us take another case, that of the plants in which the dispersion of the seeds is effected by means of hooks. Now, if the presence of these hooks was, so to say, accidental, and the dispersion merely a result, we should naturally expect to find some species with hooks in all classes of plants. They would occur, for instance, among trees and on water-plants. On the other hand, if they are developed that they might adhere to the skin of quadrupeds, then, having reference to the habits and size of our British mammals, it would be no advantage for a tree or for a water-plant to bear hooked seeds. Now, what are the facts? There are about thirty English species in which the dispersion of the seeds is effected by means of hooks, but not one of these is aquatic, nor is one of them more than four feet high. Nay, I might carry the thing further. We have a number of minute plants, which lie below the level at which seeds would be likely to be entangled in fur. Now, none of these, again, have hooked seeds or fruits. It would also seem, as Hildebrand has suggested, that in point of time, also, the appearance of the families of plants in which the fruits or seeds are provided with hooks coincided with that of the land mammalia.

Again, let us look at it from another point of view. Let us take our common forest-trees, shrubs, and tall, climbing plants—not, of course, a natural or botanical group, for they belong to a number of different orders, but a group characterized by attaining to a height of say over eight feet. We will in some cases only count genera; that is to say, we will count all the willows, for instance, as one. These trees and shrubs are plants with which you are all familiar, and are about thirty-three in number. Now, of these thirty-three no less than eighteen have edible fruits or seeds, such as the plum, apple, arbutus, holly, hazel, beech, and rose. Three have seeds which are provided with feathery hairs; and all the rest, namely, the lime, maple, ash, sycamore, elm, hop, birch, hornbeam, pine, and fir, are provided with a wing. Moreover, as will be seen by the following table, the lower trees and shrubs, such as the cornel, Guelder rose, rose, thorn, privet, elder, yew, and holly, have generally edible berries, much eaten by birds. The winged seeds or fruits characterize the great forest-trees.

TREES, SHRUBS, AND CLIMBING SHRUBS NATIVE OR NATURALIZED IN BRITAIN.

	Seed or Fruit.			
	Edible.	Hairy.	Winged.	Hooked.
Clematis vitalba		×		
Berberis vulgaris				
Lime (*Tilia Europæa*)			×	
Maple (*Acer*)			×	
Spindle-tree (*Euonymus*)	×			
Buckthorn (*Rhamnus*)				
Sloe (*Prunus*)	×			
Rose (*Rosa*)	×			
Apple (*Pyrus*)	×			
Hawthorn (*Crataegus*)	×			
Medlar (*Mespilus*)	×			
Ivy (*Hedera*)	×			
Cornel (*Cornus*)	×			
Elder (*Sambucus*)	×			
Guelder rose (*Viburnum*)	×			
Honeysuckle (*Lonicera*)				
Arbutus (*Arbutus*)	×			
Holly (*Ilex*)	×			
Ash (*Fraxinus*)			×	
Privet (*Ligustrum*)	×			
Elm (*Ulmus*)			×	
Hop (*Humulus*)			×	
Alder (*Alnus*)				
Birch (*Betula*)			×	
Hornbeam (*Carpinus*)			×	
Nut (*Corylus*)	×			
Beech (*Fagus*)	×			
Oak (*Quercus*)	×			
Willow (*Salix*)		×		
Poplar (*Populus*)		×		
Pine (*Pinus*)			×	
Fir (*Abies*)			×	
Yew (*Taxus*)	×			

Or let us take one natural order. That of the roses is particularly interesting. In the genus *Geum* the fruit is provided with hooks; in *Dryas* it terminates in a long feathered awn, like that of Clematis. On the other hand, several genera have edible fruits; but it is curious that the part of a plant which becomes fleshy, and thus tempting to animals, differs considerably in the different genera. In the blackberry, for instance, and in the raspberry, the carpels constitute the edible portion. When we eat a raspberry we strip them off and leave the receptacle behind; while in the strawberry the receptacle constitutes the edible portion; the carpels are small, hard, and closely surround the seeds. In these genera the sepals are situated below the fruit. In the rose, on the contrary, it is the peduncle that is swollen and inverted, so as to form a hollow cup, in the interior of which the carpels are situated. Here you will remember that the sepals are situated above, not below, the fruit. Again, in the pear and apple, it is

the ovary which constitutes the edible part of the fruit, and in which the pips are imbedded. At first sight, the fruit of the mulberry—which, however, belongs to a different family—closely resembles that of the blackberry. In the mulberry, however, it is the sepals which becomes fleshy and sweet.

The next point is that seeds should be in a spot suitable for their growth. In most cases the seed lies on the ground, into which it then pushes its little rootlet. In plants, however, which live on trees, the case is not so simple, and we meet some curious contrivances. Thus, the mistletoe, as we all know, is parasitic on trees. The fruits are eaten by birds, and the droppings often, therefore, fall on the boughs; but if the seed were like that of most other plants it would soon fall to the ground and consequently perish. Almost alone among English plants it is extremely sticky and thus adheres to the bark.

FIG. 16.—MYZODENDRON. (After Hooker.)

I have already alluded to an allied genus, *Arceuthobium*, parasitic on junipers, which throws its seeds to a distance of several feet. These also are very viscid, or, to speak more correctly, are imbedded in a very viscid mucilage, so that if they come in contact with the bark of a neighboring tree they stick to it.

Another interesting genus, again of the same family, is *Myzodendron* (Fig. 16), a Fuegian species, described by Sir Joseph Hooker, and parasitic on the beech. Here the seed is not sticky, but is provided with four flattened, flexible appendages. These catch the wind, and thus carry the seed from one tree to another. As soon, however, as they touch any little bough, the arms twist round it and there anchor the seed.

In many epiphytes the seeds are extremely numerous and minute. Their great numbers increase the chance that the wind may waft some of them to the trees on which they grow; and as they are then fully supplied with nourishment they do not require to carry any store with them. Moreover, their minute size is an advantage, as they are carried into any little chink or cranny in the bark, while a larger or heavier seed, even if borne against a suitable tree, would be more

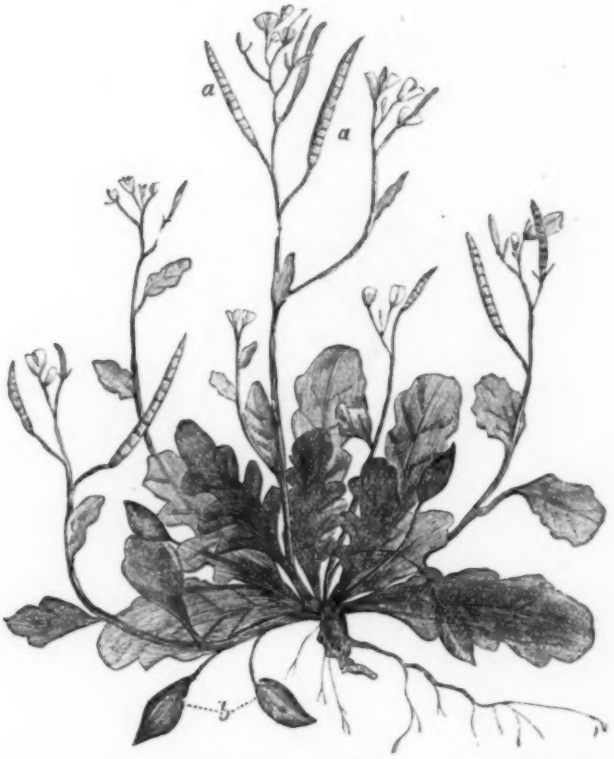


FIG. 17.—CARDAMINE CHENOPODIFOLIA. *a a*, ordinary pods; *b*, subterranean pods.

likely to drop off. In the genus *Neumannia*, the small seed is produced at each end into a long filament which must materially increase its chances of adhering to a suitable tree.

Even among terrestrial species there are not a few cases in which

plants are not contented simply to leave their seeds on the surface of the soil, but actually sow them in the ground.

Thus in *Trifolium subterraneum*, one of our rarer English clovers, only a few of the florets become perfect flowers, the others form a rigid, pointed head, which at first is turned upward, and, as their ends are close together, constitute a sort of spike. At first, I say, the flower-heads point upward like those of other clovers, but, as soon as the florets are fertilized, the flower-stalks bend over and grow downward, forcing the flower-head into the ground, an operation much facilitated by the peculiar construction and arrangement of the imperfect florets. The florets are, as Darwin has shown, no mere passive instruments. So soon as the flower-head is in the ground they begin, commencing from the outside, to bend themselves toward the peduncle, the result of which, of course, is to drag the flower-head farther and farther into the ground. In most clovers each floret produces a little pod. This

FIG. 18.—VICIA AMPHICARPA. *a a*, ordinary pods; *b b*, subterranean pods.

would in the present species be useless, or even injurious; many young plants growing in one place would jostle and starve one another. Hence we see another obvious advantage in the fact that only a few florets perfect their seeds.

I have already alluded to our cardamines, the pods of which open elastically and throw their seed some distance. A Brazilian species, *C. chenopodifolia* (Fig. 17), besides the usual long pods (Fig. 17, *a a*), produces also short, pointed ones (Fig. 17, *b b*), which it buries in the ground.

Arachis hypogæa is the ground-nut of the West Indies. The flower is yellow and resembles that of a pea, but has an elongated calyx, at the base of which, close to the stem, is the ovary. After the flower has faded, the young pod, which is oval, pointed, and very minute, is carried forward by the growth of the stalk, which becomes two or three inches long and curves downward, so as generally to force the pod into the ground. If it fails in this, the pod does not develop, but soon perishes; on the other hand, as soon as it is underground, the pod begins to grow and develops two large seeds.

In *Vicia amphicarpa* (Fig. 18), a south European species of vetch,

FIG. 19.—LATHYRUS AMPHICARPOS. (After Sowerby.) *a*, ordinary pods; *b*, subterranean pods.

there are two kinds of pods. One of the ordinary form and habit (*a*), the other (*b*) oval, pale, containing only two seeds, borne on underground stems, and produced by flowers which have no corolla.

Again, a species of the allied genus *Lathyrus* (Fig. 19), *L. amphicarpos*, affords us another case of the same phenomenon.

Other species possessing the same faculty of burying their seeds are *Okenia hypogæa*, several species of *Commelyna*, and of *Amphicarpæa*, *Voandzeia subterranea*, *Scrophularia arguta*, etc.; and it is very remarkable that these species are by no means nearly related, but belong to distinct families, namely, the *Cruciferæ*, *Leguminosæ*, *Commelynaceæ*, *Violaceæ*, and *Scrophulariaceæ*.

Moreover, it is interesting that in *L. amphicarpos*, as in *Vicia amphicarpa* and *Cardamine chenopodifolium*, the subterranean pods differ from the usual and aërial form in being shorter and containing fewer seeds. The reason of this is, I think, obvious. In the ordinary pods the number of seeds of course increases the chance that some will find a suitable place. On the other hand, the subterranean ones are carefully sown, as it were, by the plant itself. Several seeds together would only jostle one another, and it is therefore better that one or two only should be produced.

In the *Erodiums*, or cranesbills, the fruit is a capsule which open elastically, in some species throwing the seeds to some little distance. The seeds themselves are more or less spindle-shaped, hairy, and produced into a twisted hairy awn as shown in Fig. 20, representing a seed of *E. glaucophyllum*. The number of spiral turns in the awn depends upon the amount of moisture; and the seed may thus be made into a very delicate hygrometer, for, if it be fixed in an upright position, the awn twists or untwists according to the degree of moisture, and its extremity thus may be so arranged as to move up and down like a needle on a register. It is also affected by heat. Now, if the awn were fixed instead of the seed, it is obvious that, during the process of untwisting, the seed itself would be pressed downward, and, as M. Roux has shown, this mechanism thus serves actually to bury the seed. His observations were made on an allied species, *Erodium ciconium*, which he chose on account of its size. He found that, if a seed of this plant is laid on the ground, it remains quiet as long as it is dry; but as soon as it is moistened—i. e., as soon as the earth becomes in a condition to permit growth—the outer side of the awn contracts, and the hairs surrounding the seed commence to move outward, the result of which is gradually to raise the seed into an upright position with its point on the soil. The awn then commences to unroll, and consequently to elongate itself upward, and it is obvious that, as it is covered with reversed hairs, it will probably press against some blade of grass or other obstacle, which will prevent its moving up, and will therefore

FIG. 20.—ERODIUM GLAUCOPHYLLUM. (After Sweet.)

tend to drive the seed into the ground. If, then, the air becomes drier, the awn will again roll up, in which action M. Roux thought it would tend to draw up the seed, but from the position of the hairs the feathery awn can easily slip downward, and would therefore not affect

Fig. 21.—Seed of Stipa pennata. (Natural size.)

the seed. When moistened once more, it would again force the seed farther downward, and so on until the proper depth was obtained. A species of anemone (*A. montana*), again, has essentially the same arrangement, though belonging to a widely separated order.

A still more remarkable instance is afforded by a beautiful South European grass, *Stipa pennata* (Fig. 21), the structure of which has been described by Vaucher, and more recently, as well as more completely, by Frank Darwin. The actual seed is small, with a sharp point, and stiff, short hairs pointing backward. The posterior end of the seed is produced into a fine twisted corkscrew-like rod, which is followed by a plain cylindrical portion, attached at an angle to the corkscrew, and ending in a long and beautiful feather, the whole being more than a foot in length. The long feather, no doubt, facilitates the dispersion of the seeds by wind; eventually, however, they sink to the ground, which they tend to reach; the seeds being the heaviest portion, point downward. So the seed remains as long as it is dry, but if a shower comes on, or when the dew falls, the spiral unwinds, and if, as is most probable, the surrounding herbage or any other obstacle prevents the feathers from rising, the seed itself is forced down and so driven by degrees into the ground.

I have already mentioned several cases in which plants produce two kinds of seeds, or at least of pods, the one being adapted to burying itself in the ground. Heterocarpism, if I may term it so, or the power of producing two kinds of reproductive bodies, is not confined to these species. There is, for instance, a North African species of corydalis (*C. heterocarpa* of Durieu) which produces two kinds of seed (Fig. 22), one somewhat flattened, short, and broad, with rounded angles; the other elongated, hooked, and shaped like a shepherd's crook with a thickened staff. In this case the hook in the latter form perhaps serves for dispersion.

FIG. 22.—SEEDS OF CORYDALIS HETEROCARPA.

Our common *Thrincia hirta* (Fig. 13, *b*) also possesses, besides the fruits with the well-known feathery crown, others which are destitute of such a provision, and which probably, therefore, are intended to take root at home.

Mr. Drummond, in the volume of "Hooker's Journal of Botany" for 1842, has described a species of *Alismaceæ* which has two sorts of seed-vessels; the one produced from large, floating flowers, the other at the end of short, submerged stalks. He does not, however, describe either the seeds or seed-vessels in detail.

Before concluding, I will say a few words as to the very curious forms presented by certain seeds and fruits. The pods of Lotus, for instance, quaintly resemble a bird's foot, even to the toes; whence the specific name of one species, *Ornithopodioides;* those of *Hippocrepis* remind one of a horseshoe; those of *Trapa bicornis* have an absurd resemblance to the skeleton of a bull's head. These likenesses appear to be accidental, but there are some which probably are of use to the

plant. For instance, there are two species of Scorpiurus (Fig. 23), the pods of which lie on the ground, and so curiously resemble the one (*S. subvillosa*, Fig. 23, *a*) a centiped, the other (*S. vermiculata*, Fig. 23, *b*) a worm or caterpillar, that it is almost impossible not to suppose that the likeness must be of some use to the plant.

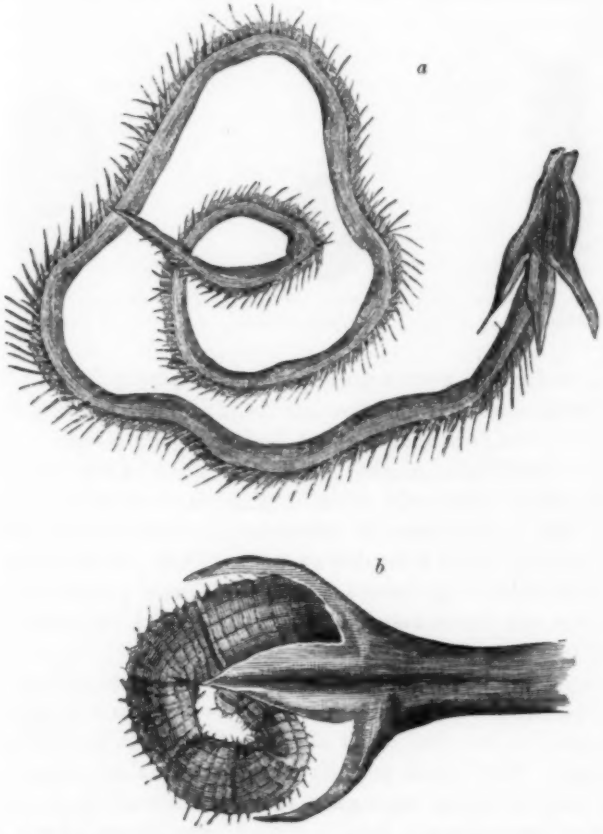


Fig. 23.—*a*, Pod of Scorpiurus subvillosa; *b*, Pod of Scorpiurus vermiculata.

The pod of *Biserrula pelecinus* (Fig. 24, *a*) also has a striking resemblance to a flattened centiped; while the seeds of *Abrus precatorius*, both in size and in their very striking color, mimic a small beetle, *Artemis circumusta*.

Mr. Moore has recently called attention to other cases of this kind. Thus the seed of *Martynia diandra* much resembles a beetle with long antennæ: several species of Lupins have seeds much like spiders, and those of *Dimorphochlamys*, a gourd-like plant, mimic a piece of dry twig. In the common castor-oil plants (Fig. 24, *b*), though the resemblance is not so close, still at first glance the seeds might readily

be taken for beetles or ticks. In many Euphorbiaceous plants, as, for instance, in Jatropha (Fig. 24, *c*), the resemblance is even more striking. The seeds have a central line resembling the space between the elytra, dividing and slightly diverging at the end, while between them the end of the abdomen seems to peep; at the anterior end the seeds possess a small lobe, or caruncle, which mimics the head or thorax of

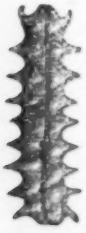


FIG. 24 *a*.—POD OF BISERRULA.

FIG. 24 *b*.—SEED OF CASTOR-OIL (RICINUS).

FIG. 24 *c*.—SEED OF JATROPHA.

the insect, and which even seems specially arranged for this purpose; at least it would seem from experiments made at Kew that the caruncle exercises no appreciable effect during germination.

These resemblances might benefit the plant in one of two ways. If it be an advantage to the plant that the seeds should be swallowed by birds, their resemblance to insects might lead to this result. On the other hand, if it be desirable to escape from graminivorous birds, then the resemblance to insects would serve as a protection. We do not, however, yet know enough about the habits of these plants to solve this question.

Indeed, as we have gone on, many other questions will, I doubt not, have occurred to you, which we are not yet in a position to answer. Seeds, for instance, differ almost infinitely in the sculpturing of their surface. But I shall wofully have failed in my object to-night if you go away with the impression that we know all about seeds. On the contrary, there is not a fruit or a seed, even of one of our commonest plants, which would not amply justify and richly reward the most careful study.

In this, as in other branches of science, we have but made a beginning. We have learned just enough to perceive how little we know. Our great masters in natural history have immortalized themselves by their discoveries, but they have not exhausted the field; and, if seeds and fruits can not vie with flowers in the brilliance and color with which they decorate our gardens and our fields, still they surely rival —it would be impossible to excel them—in the almost infinite variety of the problems they present to us, the ingenuity, the interest, and the charm of the beautiful contrivances which they offer for our study and our admiration.—*Fortnightly Review.*

HOW TO PREVENT DROWNING.

By HENRY MacCORMAC.

I WISH to show how drowning might, under ordinary circumstances, be avoided, even in the case of persons otherwise wholly ignorant of what is called the art of swimming. The numerous frightful casualties render every working suggestion of importance, and that which I here offer I venture to think is entirely available.

When one of the inferior animals takes the water, falls or is thrown in, it instantly begins to walk as it does when out of the water. But, when a man who can not "swim" falls into the water, he makes a few spasmodic struggles, throws up his arms, and drowns. The brute, on the other hand, treads water, remains on the surface, and is virtually insubmergible. In order, then, to escape drowning, it is only necessary to do as the brute does, and that is to tread or walk the water. The brute has no advantage in regard of his relative weight, in respect of the water, over man, and yet the man perishes while the brute lives. Nevertheless, any man, any woman, any child who can walk on the land may also walk in the water, just as readily as the animal does, if only he will, and that without any prior instruction or drilling whatever. Throw a dog into the water, and he treads or walks the water instantly, and there is no imaginable reason why a human being under like circumstances should not do as the dog does.

The brute, indeed, walks in the water instinctively, whereas the man has to be told. The ignorance of so simple a possibility, namely, the possibility of treading water, strikes me as one of the most singular things in the history of man, and speaks very little indeed for his intelligence. He is, in fact, as ignorant on the subject as is the newborn babe. Perhaps something is to be ascribed to the vague meaning which is attached to the word *swim*. When a man swims it means one thing, when a dog swims it means another and quite a different act. The dog is wholly incapable of swimming as a man swims, but nothing is more certain than that a man is capable of swimming, and on the instant, too, as a dog swims, without any previous training or instruction, and that, by so doing without fear or hesitancy, he will be just as safe in the water as the dog is.

The brute in the water continues to go on all-fours, and the man who wishes to save his life, and can not otherwise swim, must do so too, striking alternately, one two, one two, but without hurry or precipitation, with hand and foot, exactly as the brute does. Whether he be provided with paw or hoof, the brute swims with the greatest ease and buoyancy. The human being, if he will, can do so too, with the further immense advantage of having a paddle-formed hand, and

of being able to rest himself when tired by floating, a thing of which the animal has no conception. Bridget Money, a poor Irish immigrant, saved her own life and her three children's lives, when the steamer conveying them took fire on Lake Erie, by floating herself, and making them float, which simply consists in lying quite still, with the mouth shut and the head thrown well back in the water. The dog, the horse, the cow, the swine, the deer, and even the cat, all take to the water on occasion, and sustain themselves perfectly without any prior experience whatever. Nothing is less difficult, whether for man or brute, than to tread water, even for the first time. I have done so often, using the feet alone, or the hands alone, or the whole four, many times, with perhaps one of my children on my back. Once I recollect being carried a good way out to sea by the receding tide at Boulogne, but regained the shore without difficulty. A drop of water once passed through the rima of the glottis, and on another occasion I experienced such sudden indisposition that, if I had been unable to float, it must, I think, have gone hard with me.

Men and animals are able to sustain themselves for long distances in the water, and would do so much oftener were they not incapacitated, in regard of the former at least, by sheer terror, as well as complete ignorance of their real powers. Webb's wonderful endurance will never be forgotten. But there are other instances only less remarkable. Some years since, the second mate of a ship fell overboard while in the act of fisting a sail. It was blowing fresh ; the time was night, and the place some miles out in the stormy German Ocean. The hardy fellow nevertheless managed to gain the English coast. Brock, with a dozen other pilots, was plying for fares by Yarmouth ; and, as the main-sheet was belayed, a sudden puff of wind upset the boat, when presently all perished except Brock himself, who, from four in the afternoon of an October evening to one the next morning, swam thirteen miles before he was able to hail a vessel at anchor in the offing. Animals themselves are capable of swimming immense distances, although unable to rest by the way. A dog recently swam thirty miles in America in order to rejoin his master. A mule and a dog washed overboard during a gale in the Bay of Biscay have been known to make their way to shore. A dog swam ashore with a letter in his mouth at the Cape of Good Hope. The crew of the ship to which the dog belonged all perished, which they need not have done had they only ventured to tread water as the dog did. As a certain ship was laboring heavily in the trough of the sea, it was found needful, in order to lighten the vessel, to throw some troop-horses overboard, which had been taken in at Corunna. The poor things, my informant, a staff-surgeon, told me, when they found themselves abandoned, faced round and swam for miles after the vessel. A man on the east coast of Lincolnshire saved quite a number of lives by swimming out on horseback to vessels in distress. He commonly rode an old gray

mare, but, when the mare was not to hand, he took the first horse that offered.

The loss of life from shipwreck, boating, bathing, skating, fishing, and accidental immersion is so disastrously great, that every feasible procedure calculated to avert it ought to be had recourse to. People will not consent to wear life-preservers, but, if they only knew that in their own limbs, properly used, they possessed the most efficient of life-preservers, they would most likely avail themselves of them. In every school, every house, there ought to be a slate tank of sufficient depth, with a trickle of water at one end and a siphon at the other, in order to keep the contents pure. A pail or two of hot water would at any time render the contents sufficiently warm. In such a tank every child from the time it could walk ought to be made to tread water daily. Every adult, when the opportunity presents itself, should do so. The printed injunction should be pasted up on all boat-houses, on every boat, at every bathing-place, and in every school. "Tread water when you find yourself out of your depth" is all that need be said, unless, indeed, we add, "Float when you are tired." Every one, of whatever age or sex, or however encumbered with clothing, might tread water with at least as much facility, even in a breaking sea, as a four-footed animal does. The position of a person who treads water is, in other respects, very much safer and better than is the sprawling attitude which we assume in ordinary swimming. And then the beauty of it is that we can tread water without any preliminary teaching, whereas "to swim" involves time and pains, entails considerable fatigue, and is very seldom adequately acquired, after all.

The Indians on the Missouri River, when they have occasion to traverse that impetuous stream, invariably tread water just as the dog treads it. The natives of Joanna, an island on the coast of Madagascar, young persons of both sexes, walk the water, carrying fruit and vegetables to ships becalmed, or it may be lying-to, in the offing miles away. Some Kroomen, whose canoe upset before my eyes in the seaway on the coast of Africa, walked the water, to the safe-keeping of their lives, with the utmost facility; and I witnessed negro children on other occasions doing so at a very tender age. At Madras, watching their opportunity, messengers, with letters secured in an oil-skin cap, plunge into the boiling surf, and make their way, treading the water, to the vessels outside, through a sea in which an ordinary European boat will not live. At the Cape of Good Hope men used to proceed to the vessels in the offing through the mountain-billows, treading the water as they went with the utmost security. And yet here, on our own shores, and amid smooth waters, men, women, and children perish like flies annually, when a little properly-directed effort—treading the water as I have said—would haply suffice to rescue them every one.—*Nature.*

RECENT ADVANCE IN THE LAW OF INTELLECTUAL PROPERTY.

By BENJAMIN VAUGHAN ABBOTT.

THE indications seen during the past two years of advance in the law protecting intellectual property are interesting and important. This article will describe some of the more salient steps—the legislation and lately reported decisions—which are of interest to all friends of practical science. That such readers have a general knowledge of the system which has been established by Congress in order "to promote the progress of science and the useful arts"—the patent and copyright laws—may be taken for granted. Without rehearsing principles that have been long established, let us speak at once of matters lately questioned or newly declared.

During the last decade trade-marks became associated in the public mind with patents, owing to the fact that in 1870, when a codified statement of the patent and copyright laws was moved in Congress, that body interleaved a chapter embodying a national trade-mark law. This was done apparently on the theory that the three subjects were so homogeneous as to warrant considering trade-marks embraced within the constitutional power; and this position stood unchallenged for several years. But, when challenged, it was overthrown. The Supreme Court pointed out that the power is limited to securing to authors and inventors the right to their *writings* and *discoveries;* and said that a trade-mark can not be classified either with inventions or discoveries in the arts and sciences, or with the writings of authors; and that, if any law of Congress on the subject can be sustained, it must be one limited to marks intended for foreign (or Indian) commerce. An act has been passed (March 3, 1881) conforming to this view. It authorizes inhabitants of the United States or of any foreign country which reciprocates to register trade-marks, and protects their use in foreign (and Indian) commerce only. Trade-marks have thus been distinctly dissociated from inventions, as they should be.

Just as naturalists pronounce it difficult to draw a distinct line between plants and animals, so lawyers are finding confusion between what is a book, what a machine. A new system of book-keeping, consisting of a book of forms or blanks, the pages of which contained ruled lines and headings showing how a merchant's account-book might be prepared on a new and advantageous plan, was copyrighted; but the Court, when an imitator was sued, said that all that could be secured under the copyright law was the right to print the introductory essay, and the particular columns and headings by way of sample. To secure the control of the new system of book-keeping, the contriver

of it should have taken out a patent; for want of this, any one not reprinting his book had the right to make and use account-books framed on his plan. By way of contrast is the story of a large blank-book, each page of which was marked in spaces, these spaces being numbered to correspond with imaginary bonds and coupons, the idea being that as fast as coupons should be paid they might be kept each in the space appropriate to its number, or any notice received relative to a bond outstanding might be pasted in the space allotted to that bond, for ready reference. The contriver of this "book" patented it, and the Court said that he was right; it was not a literary work, but an invention.

All know that during ten years past improvements in the Office have been made, of which the system of printing patents for distribution and the issue of the "Gazette" are prominent examples. Improvements continue. The classification of subjects of invention has been revised, and is republished in the "Gazette" for January 4th last. As now framed it arranges patented inventions in twenty-four divisions, these being divided into one hundred and sixty-four classes, and these again into nearly three thousand sub-classes. Persons desiring to inform themselves with regard to the state of the art in any line of invention can gain much knowledge by procuring the specifications and drawings in the sub-class containing such invention, or can subscribe for future specifications and drawings in any desired class.

The number of patents which have been issued has now reached nearly a quarter of a million. To examine as many of them as is often necessary for determining the novelty of an application involves so much delay and expense that three successive commissioners have earnestly recommended the preparation of a digest. Congress, this spring, authorized this work, and appropriated ten thousand dollars for the expense.

There have been noteworthy decisions on the effect of an inventor's disclosure of his invention, or of his delay in applying for a patent, to impair his right. They indicate that the importance to inventors of "keeping their own counsel" is not sufficiently understood. An inventor may make use of his invention to test its operation, ascertain its defects, and mature improvements, quite freely; and, if these are his purposes, the facts that the use was openly known and was beneficial to the public are not fatal to his right. For example, the patent for the Nicholson pavement was contested on a showing that in 1854, before applying for a patent, the inventor laid a block of the pavement in a Boston street to test its merits. The Supreme Court said that as he had not used or allowed others to use it for profit, but only by way of experiment, there was no abandonment. But a slight disclosure by way of sale or manufacture for sale may destroy the right. For example, an inventor's making three sets of articles of ladies' wear for two ladies of his acquaintance, who wore them until they were worn

out, was pronounced an abandonment of his invention, because it was not a use for experiment or in private, but a practical use of the completed article. Even a single sale to a buyer, who bought the thing only "on trial," has been pronounced an abandonment.

A case of some hardship was that of a card-manufacturer who ran machines of his invention for several years under arrangements intended to secure secrecy: a limited number of workmen were employed; the factory-doors were kept locked, each workman having a key; and visitors were but rarely admitted. Yet no formal pledge of secrecy was exacted from those who saw the machine. In course of time the inventor obtained a patent, but in the mean time his foreman had "given away" the secret to competitors. The Judge said that an inventor's conducting his business so that the public have an opportunity of knowing and imitating his invention forfeits his right, without proof that any great number of persons knew it. If any one knew it under such circumstances that he might have made it public without a breach of confidence, the right is abandoned.

With respect to delay, while it is familiar that an inventor is not limited to any particular time within which he must apply, yet the Supreme Court has lately said, quite emphatically, that, unless he is vigilant and active in applying, or there is good excuse, such as sickness, poverty, etc., for his postponement, he runs the risk that his invention will be considered abandoned to the public. The story of the case was, that Woodbury, in 1848, applied for a patent for an improvement in planing-machines, but it was rejected. He took no further steps until 1870, and meantime the principle of his invention had been adopted by other persons. Then he obtained a patent; but it was annulled for his long neglect. Inventors should be wary of disclosure and delay.

A decision of the Supreme Court known as Mitchell *vs.* Tilghman (19 Wall., 287) has given some persons an idea that a process can not be the subject of a patent; though the intention was, only to decide that the patentee was confined in his right to the particular method pointed out in his specification. He litigated the case further, gathered additional evidence, and presented the question to the Court again; and the Court has in effect overruled its former decision, now explaining emphatically that a patent may be, under American law, granted for a process. Our patent law is not confined to new machines and new compositions of matter, but extends to any new and useful art of manufacture; and a manufacturing process is clearly an art. The principle is that, whoever discovers that a certain useful result will be produced in any art by the use of certain means, is entitled to a patent, provided he fully and accurately specifies the means. This means need not be a machine or an apparatus; it may be a process. A machine is a thing. A process is a mode of action. The one is visible to the eye—an object of perpetual observation. The other is a

conception of the mind seen only by the effect it produces while performed. But either may be the means of producing a useful result. The mixing of certain substances together or the heating of a substance to a certain temperature is a process. If the mode of doing it or the apparatus in or by which it may be done is sufficiently obvious to suggest itself to a person skilled in the particular art, then pointing out in the patent the process to be performed is sufficient, without giving directions, which would be supererogatory, as to the apparatus or method to be employed. If the mode of applying the process is not obvious, then to give a description of the process and of one particular mode by which it may be applied is sufficient. It may be that the process is susceptible of being applied in many modes and by the use of many forms of apparatus; but the inventor, if really the discoverer of the process, is not bound to describe all these in order to secure his exclusive right to it. What is required is, that he shall describe some particular mode or apparatus so as to show that the process is capable of being exhibited and performed in actual use. This is the latest utterance of the Supreme Court on the lawfulness of a patent for a process.

A decision comes from England bearing upon the value of such patents. The inventor of an improved process for making salicylic acid obtained a patent in England; but was soon undersold by an inventor of a rival process, who established a factory in Germany and brought the acid manufactured there into England for sale. The patentee brought suit. The counsel for the German manufacturer argued that the patent forbade only manufacturing in England. It did not forbid manufacturing in Germany, and any goods lawfully manufactured in Germany might be brought into England for sale. "Suppose," said he, "some one patents a process for making flour by crushing wheat instead of grinding it, and French millers, generally, adopt the mode. Is it thereafter unlawful to import flour from France?" But the Court of Appeal decided in favor of the patentee, saying that the exclusive right secured by a patent for a process must be considered to include a monopoly of the sale in England of products made according to the process, no matter where they are manufactured. For these patents expressly forbid any person directly or indirectly to use the process. Now, a person who procures the product to be made in a foreign country and then brings it to England for sale is certainly using the invention "indirectly."

Many illustrations are noticed in recent books of reports, of the expense and loss sustained by inventors through obtaining patents for trivial devices. They know, theoretically, that a patent, to be sustained in the courts, must be for an invention which is "new and useful"; but fail, practically, to apply the test. Evidently the existing system tends to betray an over-sanguine inventor. A solicitor of patents will cheerfully take a fee and undertake to obtain letters.

The patent-office will accept further fees; will make an examination for novelty, which is good, as far as it goes, and in some measure a protection against launching an unprofitable venture; and will grant a patent. A lawyer will readily spend a few hundred dollars in organizing a company, and will execute his task skillfully: he has no responsibility for the mercantile value of the project. Two or three thousand dollars more are easily expended in facilities for manufacture, in starting a sales-room, and in advertising. And yet, after all this expenditure, involving also the inventor's time, the moment the patent is contested by an infringer, the courts may pronounce it void for want of novelty. Notice recent examples. The "Perfection Window-Cleaner" was in substance a rubber mounted on a long handle convenient for reaching up to clean lofty windows and the like; the peculiarity of the device consisting in the way in which a cushion for rubbing was adjusted so that it could be pressed against the surface to be cleaned. The Court said that there was nothing new in this; the implement was only a mop or scrubbing-brush made of India-rubber. "Improved Kindling-Wood" was patented, consisting of wood tied in small bundles, each containing a lump of combustible matter which would take fire from a common match. The Court said that there was no more invention in this than there would be in selling a sherry-cobbler glass with a straw in it, or a can of food with a fork. As at first devised, the "Fare-Box" used in city omnibuses and street-cars was inefficient for want of an opportunity to the driver to see whether the proper fare had been put in. Some one obtained a patent for the improvements of fitting a second window, and a reflector, in such manner that the driver might, either by day or night, see the coin which had been deposited. With these changes the fare-box became a success. But the Court said that there was no invention in inserting an additional window, or in putting a reflector near a lamp. To relieve drivers from the necessity of buying a new whip because the tip-end had become frayed or broken while the stock remained good, an inventor contrived "Whip-Tips" with sockets, so that a worn one might be unscrewed and a new one screwed on in its place. The Court said that he might sustain an exclusive right to his screw, but that the important feature of the device—making independent tips to be substituted for worn ones—was not new; this is the principle upon which fishing-rods in sections have been made for many years. The "Rubber-tip Pencil" has had an extensive sale; but, when the patent for it was contested, the Court said that there was no invention; the device was nothing but "a piece of rubber with a hole in it." Not many years ago a patent was questioned for an article called "Comminuted Glue." The device consisted in breaking glue into small particles, of uniform size, to facilitate dissolving it for use. The Court said that nothing was here involved other than grinding glue fine, and grinding can not be called a new invention. A score of such decisions might

easily be gathered from the court reports of the past two years, showing very clearly that inventors need to be on their guard against soliciting patents for trivialities.

That an applicant for a patent must frankly and fully disclose his invention, but that if his description is, through accident or mistake, insufficient, he may have a "reissue" correcting the mistake, is familiar, yet not so well understood but that new explanations have been found needful. The volume published last summer of Justice Clifford's decisions contains a case in which he assigns three reasons for requiring fullness and accuracy in the description: 1. That the Government may know what they have granted, and what will become public property when the term of the monopoly expires; 2. That licensed persons, desiring, during the term, to practice the invention, may know how to make, construct, and use it; 3. That other and subsequent inventors may know what part of the field of invention remains unoccupied.

The privilege of reissue has no doubt been abused. A glaring case was presented in the Supreme Court. An inventor applied for a patent, but the Commissioner thought that he claimed too much, and refused letters unless the applicant would omit a part. He did so, and a patent was issued for the invention, the description being limited according to the Commissioner's view. Several years afterward, he applied for a reissue, to include the feature of his invention formerly rejected, and, through some error, it was granted. The Supreme Court Judges say that this, though it has often been done, is a fraud on the public. Reissues can only be allowed to cure errors attributable to inadvertence, accident, or mistake. What was omitted from the first patent, because the inventor consented to abandon it, can never be lawfully brought in afterward by a reissue.

Several lawsuits have culminated in a group of decisions which, if they shall be sustained by the Supreme Court, will open the way to an efficient judicial remedy, whenever Government officers assume to use a patented invention. The English idea has long been that a patent is a monopoly or privilege which the Crown—though forbidden to grant monopolies as freely as might be done centuries ago—may give to a favored person. Hence it is there considered that the privilege does not prevail against Government. The Crown does not engage not to use the improvement. Upon the American view, a patent is a compact made with the inventor to induce him to disclose his invention for the public benefit; as a reward for which he receives an exclusive privilege which is in the nature of property. As respects many important inventions, the privilege would have little value if not good against Government, for the reason that the thing is only useful in Government business. What would be the worth of a patent for articles useful only in the army and navy, for a revenue or postage stamp, or the like, if Government might use the invention free? Offi-

cers have, however, influenced by what is said in English books, often supposed that no royalty need be paid when Government authorizes the use. Thus, a while ago, an army officer who contrived an improved cartridge-box submitted it to the War Department, and the department adopted it, but refused to pay the inventor. He sued in the Court of Claims, which said that the case was to be treated as if Government had agreed to pay a reasonable price. More recently, when Mr. James, the Postmaster of New York City, used a patented invention for canceling postage-stamps, with the result of saving to the Government, through a term of years, some sixty thousand dollars, the Circuit Court said that he must pay damages in the same light as if he had been an infringer on his own account, and must obtain reimbursement from Congress as he might be able. Attorney-General Devens gave an official opinion to the like effect. Upon the theory of these decisions, if a patented invention is used in Government business with the inventor's consent, the Court of Claims may award him compensation upon an implied contract to pay; or, if it is used against his will, he may prosecute the officer as an individual, and the interest of Government in the matter will be no defense.

RECENT ADVANCES IN ELECTRIC LIGHTING.*

By W. H. PREECE.

ADVANCES have been made, not so much in electric lighting itself as in the popular favor with which it is regarded. The public is becoming more accustomed to its use, and is acquiring more confidence in it. The result of trials during the last year or two has been to make the defects of the electric light better known. It has been taken out of the experimental stage, and brought within reach of the practical stage. The principal fact which has brought the electric light to the front has been the substitution of machinery for the direct conversion of mechanical energy into electricity for the expensive batteries which were the only sources a few years ago. Machines, working with high velocity, great steadiness, and uniform pressure, have solved the problem of cheap electricity. The amount of coal required to produce one horse-power has been reduced from seven and eight pounds to three and even two pounds. The gas-engine—a very economical source of energy—has been successfully applied to electric lighting in many places. Such an engine has been used at the docks in Newport, South Wales, to produce a light of eleven times the power that the same gas would give if used directly.

* Abstract of a lecture before the London Society of Arts.

Here is a sphere in which gas companies may maintain their dividends. Water furnishes a convenient source of energy wherever it can be found available. Sir William Armstrong makes his brook light his house, producing from it, by the aid of a turbine, a force giving six horse-power. The caloric-engine at the Lizard Lighthouse has been found to be economical, useful, and very suitable for an isolated place where it is hard to provide water.

The difference in the value of the several excellent machines employed for generating the current is not great. Each is especially adapted for its own particular work, either by a variation in velocity or by a variation in the manner in which the wire is wound, so as to produce a variation in the current produced to suit the particular light required. In both the Siemens and the Gramme machines ninety per cent. of the power is converted into useful current. It is easily demonstrable that there is economy in the use of small machines. Trials made for the Trinity House have shown that more efficiency is obtained by joining small machines in multiple arc than by using a larger machine, or joining the same small machines in series.

For conducting-wires the preference is given to copper, the purest that can be got, and wire of the largest dimensions consistent with economy, so as to keep the resistance as low as possible and avoid waste of energy. When it can be carried overhead, facility is given for the radiation of the heat into the air, and the wire is kept cool and conveys more electricity. Since the currents to be carried over these wires are three thousand times larger than those used in telegraphy, the difficulties to be encountered in their safe transmission are greatly magnified. The disturbing effects produced by the inductive influence of such currents are so serious that apprehensions are entertained that it will be impossible to maintain electric light and telegraph currents close together.

The electric light is coincident with electric heat; the art of producing a brilliant light is the art of producing a high temperature. No greater illusion is extant than the idea that the electric light is a cold light, for the electric arc is the greatest source of heat known. This heat can be produced either by causing the electricity to fly across an air-space, in which case we have light by the arc, or an arc-light, or by causing it to flow through a small wire or a carbon filament, which offers obstruction to the flow and produces light by incandescence, or the incandescent light. The forms of arc-lamps are very numerous. In every case carbon rods are opposed to each other, and are disintegrated and consumed in the fierce blast to which they are subjected. The lower pole—the negative—acquires a temperature of 3,150° C. (5,702° Fahr.), and is broken up and fired in a fierce bombardment of white-hot molecules across the air against the upper pole —the positive—which is beaten up by incessant impacts into a higher temperature of 3,900° C. (7,052° Fahr.), the arc itself being 4,800° C.

(8,672° Fahr.). A number of ingenious appliances have been adopted to obtain steadiness and uniformity in the action of the arc, which is liable to variations arising from the irregularity in the character and consequently in the consumption of the carbon, and from variations in the strength of the current. We want brilliancy combined with absolute steadiness, and a durability equal to the length of a winter's night. All the improvements that have been made in the arc have not given a silent and steady light.

The incandescent light is free from many of the defects of the arc-light. In it we have something that is beautifully soft, absolutely noiseless—a light that brightens up Nature in all her true colors and purity. It, however, requires a considerable expenditure of power, and is at present an expensive luxury. Sir William Armstrong finds that six horse-power will supply thirty-seven lights, giving altogether the illumination of nine hundred and twenty-five candles. The same power applied to arc-lights would give more than six thousand candles. But rapid progress has been made in this field. Maxim, Edison, etc., in America—Swan, Lane-Fox, and others, in England—are working hard; while Gordon and Joel are working in an intermediate field, in which a prospect appears of a happy compromise being effected between the arc and incandescence.

Some wild statements, involving wonderfully divergent estimates, have been made about the light-giving power of the different lights. A standard sperm-candle, although it may be a good unit to measure gas by, is a very poor standard for the electric light. None of the various modes of measurement in use seem to apply exactly to this light, and the standard of measurement of the future has yet to be found. Much is said about the subdivision of the electric light by certain gentlemen, who hope to distribute it throughout our houses from one central spot, and furnish it cheaply and abundantly in our cities. I am one of those who do not believe in the impossible, but I say that, with our present knowledge, this problem is unsolvable. Sir William Armstrong can only keep thirty-seven lamps going; Lane-Fox could only show twelve lights; Professor Adams could only produce from the most powerful dynamo-electric machine, by calculation, one hundred and forty lamps. Where is the subdivision? The advocates of subdivision assume an inexhaustible source of electricity. Their opponents reply that there is but a very limited source of energy in every dynamo-electric machine. It may be that more powerful machines and lamps of lower resistance may enable us to light up a greater number on one circuit, but this is not subdivision, it is multiplication.

For application to external illumination, we have, first, the centralized system of Dr. Siemens, in which one machine works one powerful light, raised like a small moon on the top of a high mast; and, secondly, the distributed system of the Brush Company, who utilize the existing

street lamp-posts, one machine working many lights. The former system appears to be the best for symmetrical spaces and large areas, the latter for long and narrow streets and thoroughfares ; so, in internal illumination, the central system is preferable for lofty, spacious rooms, the distributed for long and low ones.

An eventful feature in practical lighting is the proper scattering or diffusion of light, by shades, screens, and reflecting surfaces. We want to emulate the diffusion of daylight. It is marvelous how white-washed surfaces do this. Well-selected globes act as though they were self-luminous ; they scatter light and produce shadows. The power of the light, however, to penetrate fogs does not appear to be any greater than that of gaslight. This is because the shorter-waved rays that give the light its violet tint are checked by the vapors, in the same manner as the like rays in the sun are checked, and it is made to appear red. The same cause operates to give the electric light a greater illuminating power in its immediate neighborhood, for the checked rays are reflected back to add their intensity to that of the direct rays.

Nearly three hundred Gramme machines are in use in England generating light ; there are many more Siemens machines, and the Brush people have installed many machines and lights. Nearly all the ironclads in the navy are supplied with the electric light. In libraries, while reading by gaslight is irksome, reading by the electric light is simply delightful. Railway-stations are gradually adopting the lights ; seaside resorts are illuminating their parades with them. It would be impossible to make any summary of the numerous manufacturing establishments that have been supplied with lights worked successfully.

Notwithstanding these great advances in its use, it must not be forgotten that the electric light has its defects and its disadvantages. The intense shadows that it occasions are troublesome. The unsteadiness of the light is at times wearisome. The hissing which impurities in the carbon and irregularities in the current produce is tantalizing, and the light has an unfortunate habit of misbehaving itself when it is most wanted. Moreover, the problem of durability remains yet to be solved. Many have tried the light and abandoned it. In some cases its economy is unquestionable, but there are places where careful persons have shown that gas, as regards economy, surpasses it. It is questionable whether, in some cases, the electric light does not affect the eye. The arc-light produces, also, nitrous acid and other deleterious gases, but the incandescent lamp is free from this trouble. The powerful currents that it requires can not be carried over buildings and rooms without incurring danger from fire and to life. Nevertheless, the light has great and manifold advantages. The brilliancy of a well-lighted room is simply enchanting. The purity of the light for the transaction of business, the selection of colors, and the ordinary daily avocations of life, is simply superb. Its cleanliness is one of its great merits. It

emits no smoke. Probably its greatest advantage is to be found in the influence it exerts on health. At Glasgow, where the light has been applied, all causes of trouble arising from the vitiation which was occasioned by other lights have ceased. Health has been engendered, and more work has been got out of the men; and experience has shown that the electric light will pay for itself in the superior return it makes in this point alone.

Mr. Preece has published in a separate paper some facts bearing upon the economy of the electric light. The Loan Court of the South Kensington Museum, a room not favorably arranged for the diffusion of light, has been lighted for nine months with sixteen Brush lamps, at a cost for working of 3*s.* 10*d.* per hour of light. Had gas been used, a consumption of sixteen hundred cubic feet per hour would have been required, at a cost of 16*s.* Considering that the museum is lighted up for seven hundred hours every year, the total saving effected by the use of electricity is at the rate of £426 or $2,130 a year. It is fair, however, to add something for the use of the capital, wear and tear, etc., to the annual expense. Reckoning this at five per cent. all around, the annual saving is still £316 10*s.*, or $1,580. The reading-room of the British Museum is lighted by the Siemens electric light, at a cost of 5*s.* 6*d.* per hour, one third of what would be required for gas, were it used. A shed at the sugar-refinery of Messrs. Henry Tate & Sons, Silvertown, is lighted by a Crompton lamp in the ceiling, assisted by a canvas reflector. The whole of the shed is well lighted—four or five times more strongly than with gas—and the light penetrates an adjoining shed. The cost for fourteen hours of illumination is 1*s.* 9*d.*, or 1½*d.* an hour; the cost of illumination by gas was 3*s.* 6*d.*, or 3*d.* an hour. At the ship-building dock, Barrow-in-Furness, a work-shed is lighted by Brush lights at £4 14*s.* a week, where oil blast-lamps were formerly used at £8 9*s.* a week; and the erecting-shop, formerly dimly lighted by gas at £22 a week, is now efficiently lighted by electricity at half the cost.

DEGENERATION.

By Dr. ANDREW WILSON.

IN groups of the animal series, both nearly allied to the crustacean class and far removed from it in structure, equally interesting and often curious examples of degradation may be found. The class of insects and the nearly related group, including the mites, spiders, and scorpions as its representatives, number in their ranks instances of degraded and degenerate forms. Among the insects which are parasitic in habits a notable absence of wings is discernible, and this

latter want is seen even in those cases in which one sex alone of a particular insect species assumes the habit in question. An excellent illustration of such a fact, and also of the extreme modification of form which may accompany the degeneracy of highly organized animals, is found in the history of the insects collectively known as *Strepsiptera*, and of which the genus *Stylops* is the best-known example. The male stylops (Fig. 13, *a*) is an active insect, possessing a

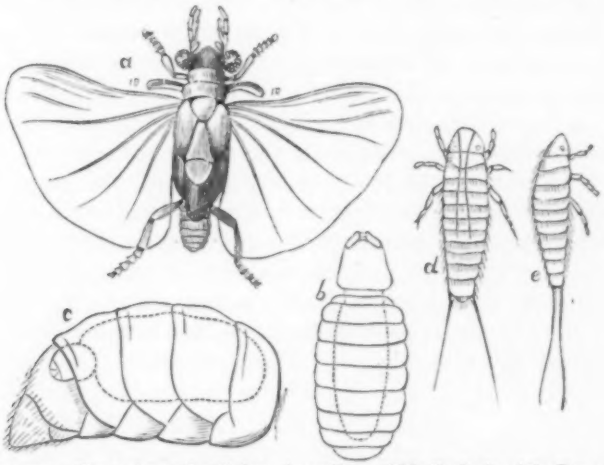


Fig. 13.—Stylops. (Fig. *c* shows the Stylops, in outline, within the body of the Bee; and Fig. *b* shows the Stylops removed from the body of its host.)

single pair of wings. These wings are the hinder pair; the front pair being represented by a pair of twisted organs (*w*), which illustrate wing-degeneration, possibly through disuse. Both males and females as they leave the egg are small, active, six-legged beings (*d*, *e*), which crawl about on the bodies of bees. Carried into the hive, the young stylops behave like the proverbial viper, injuring the community which gives them shelter by boring their way into the bodies of larval or infant bees. Here the young stylops, casting their skin, become in the larval interior sluggish, footless grubs. Each possesses a mouth, small jaws, and a digestive system of simple construction. Meanwhile, bee-development progresses; and, as the larval bee passes through its chrysalis state with its stylops-lodger contained in its interior, the latter thrusts the front extremity of its body from between two of the hinder body-segments of the bee. Then the male stylops, undergoing development in this position, becomes the winged insect (*a*) and passes into the world. The female stylops (*c*), on the other hand, remain in their places on the bees. They undergo but a slight change of form, persisting as mere sac-like bodies (*c*), without legs or digestive system (*b*), and develop in their interior the eggs from which succeeding generations of stylops will be produced. Such a case of absolute degeneracy is all the more remarkable in view of the facts that it

is limited to one sex alone, and that the free-winged males of stylops are as highly organized as most of their neighbor insects.

The class of the spiders (*Arachnida*) offers collective examples of degeneration and retrogression, which show how large numbers of animals may acquire lower characters, contrasting with the higher phases to which other members of their class have attained. The mites and ticks have unquestionably originated from the same root-stock as the spiders and scorpions. The development of the two groups proves this much. But, while the latter animals have advanced to a high complexity of organization, the mites and ticks have degenerated into parasitic forms—or at least exemplify beings which, first attaining a respectable rank in their own series, have certainly not advanced upon that rank. Many of the mites, however, exhibit well-marked degeneration. Only on the hypothesis of sweeping retrogression can we account for the singular and anomalous condition in which a certain harmless mite, named *Demodex folliculorum* (Fig. 14), spends its existence. This mite inhabits the sacs or follicles of the human skin at the sides of the nose. It is a minute, worm-like animal, possessing eight degenerate rudiments of legs, and a thoroughly rudimentary structure in other respects. Here parasitism has denuded the

FIG. 14.—DEMODEX (magnified).

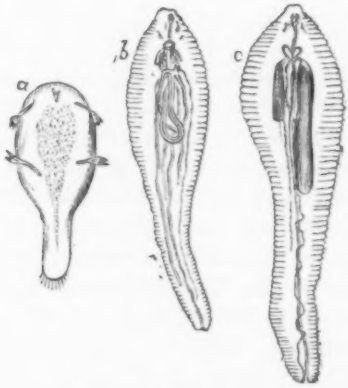


FIG. 15.—LINGUATULINA.

animal of wellnigh every attribute of its Arachnidan character, and has left it in a condition analogous in many respects to sacculina itself. Of the equally curious *Linguatulina* (Fig. 15), inhabiting the "frontal sinuses" or forehead spaces of dogs, wolves, horses, and sheep, the same remark holds good. The body here is thoroughly worm-like in shape (*b*, *c*), and a digestive and nervous system are to be enumerated among the possessions of the organism. But not even the rudiments of legs are to be perceived, although the mouth bears certain apologies for the appendages proper to that region in the mite and spider class. Yet the young linguatulina (*a*) exactly resembles the early form of the

mites. It possesses two pairs of jointed limbs, and certain style-like organs pertaining to the mouth. There is thus the clearest evidence that linguatulina is a degraded animal. It is the degenerate descendant of a free-living and apparently four-legged—or it may be eight-legged—ancestor; and its further history seems to afford a clew to the causes of its retrogression. For the four-legged larvæ of linguatulina escape, while still within the egg, from the nose of the dog or sheep host which has harbored their parents. Received along with food into the body of the hare or rabbit, the larval being liberates itself. From the rabbit's digestive system it bores its way through the tissues to the liver, thus reminding one strongly of the similar migrations of the embryo tapeworm. In the liver further changes ensue. Frequent moltings become the order of the day, and at length they assume a worm-like aspect and remain thus, still imperfect, until, by transference to the body of dog, wolf, or sheep, and by passage to the frontal sinuses, they acquire perfection of their life-functions. If the history of these beings teaches us anything concerning their past, it points to a free and active state as their original condition, and to the probable acquirement, first, of a lodgment in the digestive system of one animal as a relatively simple parasite; and, secondly, of a further modification of habit, transferring at once its perfection and completed degradation to the forehead cavities of a second host.

But the conditions which make for the degeneracy of an animal are, as we have seen in the case of the barnacles, not always associated with a parasitic habit. Mere fixation, as we have observed, secures the disappearance of useless organs, such as organs of motion and sense-organs, which, being possessed by the young form, clearly indicate that the ancestry of the animals in question has at any rate been capable of leading to better things than the descendants represent in their existent persons. The sea-squirts, or ascidians, besides serving as a text for the derivation of vertebrates, and for abnormal ways in the animal chemistry which imitates the plant's work, have been selected as fruitful objects of discussion by those biologists who find in the idea of degeneration an explanation of knotty points in natural history. For the same voice that proclaims the fact that a sea-squirt —which is a mere rooted bag with a double neck (Fig. 16)—begins life as a free-swimming, tadpole-like larva (Fig. 17, 5), tells us in the same breath that there must have been retrogression and degeneration from an active condition to produce the sac-like adult state. The assertion that the youthful sea-squirt, moreover, possesses first a rod-like body—called the *notochord* (Fig. 17, *n*)—only found besides in the young of vertebrate animals, is also to be taken as implying the superiority of ascidian infancy to sea-squirt maturity. And, when it is added that the elderly squirt wants the sense-organs and nervous cord which the larva possesses, it may well be argued that sheer degeneracy of habit and structure can alone account for the sweeping transformations

which mark the phases of ascidian life-history. Thus it is matter of sober, natural-history fact that a sea-squirt larva, of all invertebrate animals, is the only being that possesses organs and parts proper to the young vertebrate or to the *adult* form of one lower vertebrate in

FIG. 16.—SEA-SQUIRT.

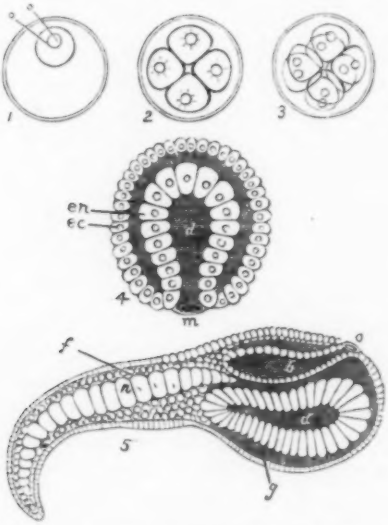


FIG. 17.—DEVELOPMENT OF SEA-SQUIRT.

particular. This adult is the little fish known as the lancelet, which, in the relative simplicity of its organization, makes a nearer approach to the poor or sea-squirt relations of the vertebrates than any other fish.

The fact of vertebrate and sea-squirt relationship is worth dwelling upon, because the topic unquestionably presents one with a common point of view, whence a survey of the higher development, evolution, and progress of the vertebrates, and a view of the degeneracy and retrogression of the sea-squirts, may best be obtained. Reveling in the freedom of its early life, the larval sea-squirt—presenting, as already noted, a striking resemblance to the tadpole of the frog, in its backbone, its nerve-system, and its breathing-sac, or modified throat—ultimately settles down. Like the youthful barnacle somewhat, the young sea-squirt attaches itself to a stone or shell by the suckers with which nature has provided its head. Then succeeds the disappearance of the tail, with its backbone and its nerve-cord, and the body itself soon assumes the sac-like shape that betokens the mature ascidian character. The outer skin becomes tough and leathery, and develops the *cellulose* which, by biological right, we should expect to find in plants alone. Then succeeds the fuller formation of the gill-sac or breathing-chamber, and of its neighbor compartment, which receives the effete water of respiration to be ejected by the second mouth of the sac-like

body. The eye of the larva likewise disappears, and all that remains to the adult ascidian is a nerve-mass, called by courtesy the "brain," and which serves to regulate the few acts that mark the placid and rooted existence of the race. Attention has been recently directed in a special manner to the resemblance which exists between the eye of the larval sea-squirt and that of vertebrates—a statement to be taken along with that which conversely declares the unlikeness of the ascidian eye to that of all other invertebrate animals. It is matter of fact that the chief parts of the eye of a vertebrate animal grow inward as developments from the skin, and unite with an outgrowth from the brain. This outgrowth forms the *retina*, a nervous network of the eye, whereon the images of things seen are duly received for transmission to brain and sensorium. Now, in invertebrate animals the retina is formed from the skin-layer. This latter method of growth, it has been remarked, is a perfectly natural one. It was to be expected that, as the retina is to be affected in the discharge of its duty by light-rays, it should form on the surface of the body where the light-rays fall. In the vertebrate, and in the sea-quirt larva, the retina, on the contrary, forms away below the skin-surface, and grows outward from the brain. Why is this so? Professor Ray Lankester maintains that because the ascidian larva is perfectly transparent, the light-rays pass through to its brain-eye, and thus give rise to sensations of sight. Hence, if the original and primitive vertebrate animal or root-stock were like the larval sea-squirt, as we suppose it to have been, its body would be transparent, and its eye or eyes, situated on its brain, would receive light-rays through its clear body. But, as the evolution of the vertebrate race proceeded, the tissues became firmer and denser. By "natural selection"—or, in other words, by the exercise of accommodating power to function—the eyed region of the brain would tend to grow more and more toward the body's surface, to receive the rays of light. As development, therefore, proceeded, the mode of growth of the vertebrate eye would be adapted to the exigencies of its new surroundings. Thus, to-day, the vertebrate eye grows from without inward, because light-rays strike naturally on the outer surface of the body. But it likewise grows from within outward as well, because of the ancestral and hereditary tendencies which cause it to repeat in the individual growth the passage to the surface it had to make in the evolution of the race. If one might add a suggestion to such an explanation, it would consist in an endeavor to account for that affinity between brain and outer surface of body which we see to exist. Why the brain should grow outward, as it does in eye, ear, and nose likewise, to connect with the body's surface, and so to form organs of sense, is plain enough. We must bear in mind that the brain itself is formed from the outer layer or *epiblast* of the larva, and from the same layer which develops into the skin. Brain and skin, to begin with, arise from the same layer. Hence, before even the matter of

eyes falls to be considered, the affinity of the skin-layer and the nervous system is a fact worth noting. It is this truest of relationships which may reasonably enough explain, not merely why the sense-organs arise from the skin-surface, but also why the brain grows outward to meet with the structure to which it is so near akin.

Degeneration of a very pronounced kind thus accounts for the peculiarities of sea-squirt structure to-day. The case of ascidian retrogression is likewise the more interesting, seeing that its reverse side is that of progressive evolution and development of the highest forms of life the existing world knows. It is, therefore, important to note in passing that the possibilities of development may include degeneration of a very marked type, along with progressive evolution of equally pronounced kind. The category of life's extension includes, in fact, many possibilities which at first sight might appear of most unlikely kind ; and, among these possibilities, that of extreme degeneration is by no means the least notable as an element in inducing the material variety of life we behold in the animal and plant worlds of to-day. The list of causes which lead to the degeneration of living beings includes, however, other fashions of producing retrogression than by fixation and parasitic habits, and operates in different ways upon organisms of varied structure and social or biological rank. Changes in food and feeding may thus accomplish degeneration and induce physiological backsliding of the most typical description. It is a familiar fact that the animal organism is of relatively higher nature than the plant, seeing that the animal frame can, as a rule, feed upon and build up its tissues from organic or living matter only. Animals, in other words, demand the substance of other animals or of plants, or of both combined, as a necessity of their commissariat arrangements. Plants, on the other hand, are specially constructive and elaborative in their feeding. They build up from the non-living matters around them—carbonic acid, water, ammonia, and minerals—the tissues of their living bodies. They "transubstantiate" this non-living matter into living tissue ; and the verdant tints of spring, the full glory of the summer's blossom, or the mellow ruddiness of autumn's fruits, represents, each in its way, the result at once of the plant's constructive chemistry and of the elaboration into living matter of the inorganic materials of air and soil around.

The animal frame, therefore, presents us—amid exceptions to the above rule in both animal and plant series—with relatively greater complexity of organs and tissues than the plant-body presents. This statement simply reëchoes what commonplace observation daily demonstrates. Hence, it may be a natural enough inference that whatever causes tend to bring the animal feeding nearer in type to that of the plant will tend to simplify animal structure, and so to produce retrogression and degeneration of the animal type. Many animals are thus known to develop *chlorophyl*, or the green color we see charac-

teristically in every leaf. Through the combined operation of this green color—either singly or aided by the leaf-protoplasm—and the action of light, plants decompose the carbonic acid of the air, as every schoolboy knows, and, retaining the carbon to aid in the formation of

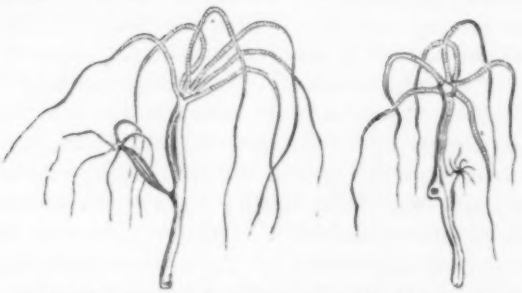


FIG. 18.—HYDRÆ. (In both figures young hydræ are represented budding from the side of the parent).

starch, set free the oxygen, which thus returns to the atmosphere, and is welcomed by the animal hosts. The hydra, or common fresh-water polyp (Fig. 18), many animalcules, and certain worms of a low type, possess this chlorophyl. Like dishonest manufacturers, they seem to have infringed the patent-rights of the plant to elaborate this green color. And it is no longer matter of theory, but ascertained fact, that these green animals are capable, like the plants, of absorbing carbonic acid—usually a fatal gas to the animal constitution—and of elaborating starch therefrom like their plant neighbors. Thus a simpler mode of feeding, obviating the necessities of animal existence in the way of digestive apparatus, has apparently led to the simplification of structure. Degeneration has followed in the worms just mentioned, as the result of their imitation and acquirement of vegetative powers of feeding; and it is probable that other alterations in the way of dietary, of less sweeping character than that just mentioned, will affect, in like retrogressive fashion, the animal constitution.

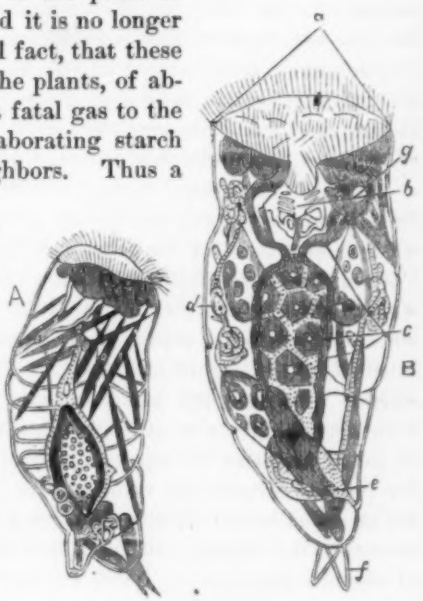


FIG. 19.—ROTIFERA.

Some of the most curious cases of degeneration known to us illustrate the total disappearance of digestive apparatus even in some beings, in which, as in the stylops already mentioned, one sex becomes

retrogressive while the other sex remains structurally fully developed. Such a case is illustrated by the males of those remarkable organisms, the *Rotifera*, or "wheel-animalcules" (Fig. 19). These minute creatures, inhabiting our fresh waters, may be desiccated and dried, and revived, on the application of moisture, many times in succession. But in their ordinary existence, and in the details of their structure, the "wheel-animalcules" present details equally interesting with their exhibition of "potential vitality." The female animalcules possess a complete digestive system, a set of water vessels, a nervous ganglion, and other belongings; but their partners are decidedly inferior creatures, since their digestive system becomes totally abortive, while in size the males are likewise far excelled by the lady rotifers. How this degeneration and disappearance of digestive apparatus and the inferiority of size have been produced in the male rotifers may be a matter regarding which difference of opinion will certainly exist in biological minds. The fact that retrogression is here illustrated, however, can not be questioned. It may also be added that, in all probability, the extreme development of the function of perpetuating the species and the extraordinary fertility of production witnessed in these animalcules, may satisfactorily account for the abrogation of digestion in favor of reproduction. Thus, to the other causes of degeneration in animal life and structure, we may append that which takes origin from the extreme or excessive development of one function over another. Physiological development in one direction, overstepping the natural and ordinary limits, runs concurrently with destruction of life's equilibrium, and naturally tends to produce degeneration and simplification of other organs and other duties of life.

How far the theory of degeneration we have thus briefly discussed may be applied in explanation of the peculiarities of animal structure, remains as a task for the future of biology to satisfactorily determine. Possibly the corrections which the future of every hypothesis carries with it may be many and sweeping. The deductions and inferences we extract from a study of degeneration to-day may perchance be falsified by the higher and newer views of the to-morrow of biological science. But enough has been said to show that, even in a cursory review of the doctrine of degeneration and retrogression, many phases of living histories become theoretically plain; and it argues hopefully for the correctness and value of the doctrine before us that it has, so far as it has been logically pursued, fitted compactly and harmoniously enough with ascertained facts and with received views of the origin of animals and plants. That higher forms of life than the sea-squirt and insect race are by no means exempt from the influence of retrogressive change is an observation worth noting at the close of our researches. We know, for instance, of lowly structures in shell-fish life appearing in the midst of highly organized frames. A mussel, a cockle, or an oyster, whose early development runs in parallel lines

to that of the snail and whelk class, is nevertheless esteemed less highly organized than the latter. The mussel or oyster tribe possess no head; the snails and their allies, as every one knows, not merely exhibit a well-developed head, but have that extremity provided with eyes, tentacles or feelers, and other addenda of the front region of the animal body. Hence it is more than probable that the mussel, headless and inclosed in its shell and possessing relatively little interest in the affairs of the outer world, is an example of a degenerated type of mollusks. The mussels and their relations stand, in fact, at the opposite extreme of development in this respect from those well-known mollusks, the cuttle-fishes. In these creatures, the tendency to head-development—or what Professor Dana calls "cephalization"—reaches its maximum, as any one may readily enough suppose on looking at an octopus or squid, with its great head, its enormous eyes, and its nerves massed together to form a brain inclosed in a kind of skull. Even as compared with the earlier cuttle-fishes—whose shells, under the name of ammonites and the like, we find fossilized in large numbers—the squids and cuttles of to-day present, in the extreme development of head, a noteworthy advance. Thus, while the one molluscan tribe of mussels and their neighbors has degenerated and gone to its own lowly place in the series, other groups, starting on an equal footing, have advanced, and, through progressive evolution, have produced those higher manifestations of molluscan life that teem in the seas of to-day. Even among the vertebrate animals we meet with examples of degenerative tendency which are not so easily explicable as the foregoing illustrations. In most snakes only one lung is fully developed, as a rule, the companion organ being rudimentary and degenerate. In birds, the egg-producing organs are similarly developed on one side only. How degeneration should be thus partial and affect one half of an animal's frame, so to speak, is very hard to discover. External conditions of life and the influences of surroundings could apparently possess little effect in inducing such an unsymmetrical retrogression of parts. Most probably we shall find the solution of such conditions to exist within the operation of some deep-seated law of the living constitution, and in the effects of that law in molding, or even contorting, the animal frame.

It constitutes one of the chief glories of biological science, as pursued among us to-day, that its studies are of far-reaching order, and lead, as the results of their natural extension, to the consideration of fields of thought often widely removed from the original topic which interests the reader. The present subject of degenerative changes, regarded as part and parcel of the living constitution, can readily be shown to possess applications far removed from zoölogy and botany, and extending into the most intimate spheres and phases of human history itself. Degenerative change in human tissues is medically symptomatic of very many of the ills to which flesh is heir.

Tissues and organs degenerate in individual animals, as animal frames retrogress in their entirety. Cells retrograde and fibers degenerate in our bodies, just as the sea-squirt's frame exhibits, as a whole, a universal, physiological backsliding. Nor may many of our diseases alone be esteemed mere examples of degeneration affecting our tissues. The termination and decline of life itself and the age that really "melts in unperceived decay" are, in reality, examples of natural degeneration also. The decline of existence is largely a retrogression of structure. There can be no such thing as a really "green old age," any more than we can speak of "the sere and yellow" of the autumnal leaf as imitating the verdant nature of the spring blossom. Nay, stranger still is it to discern that the full flush of life's vigor is accompanied by degenerative changes as typical as those which mark life's decline. For every tissue wastes as it works; and cells degenerate, die, and are cast off from every surface and tissue of our frames as the natural result of living and being. "Generally speaking," says a writer, in discussing the degeneration of human tissues, "those parts which live most slowly are those of which the duration is the greatest, and in which there is consequently the least frequent change. Of the exuviation of epidermic structures *en masse*—a process altogether comparable to the fall of the leaf—we have striking examples in the entire desquamation of serpents, the molting of the plumage in birds, and the shedding of the hair in mammalia; and, in the shedding of the antlers of the stag, we have an example of the exuviation of a highly organized and vascular part, which periodically dies, and which, being external, is cast off entire. 'What means all this,' says Sir James Paget, 'but that these organs have their severally appointed tissues, degenerate, die, are cast away, and in due time are replaced by others, which in their turn are to be developed to perfection, to live their life in the mature state, and to be cast off?'" And, again, the same high authority remarks that "it is, further, probable that no part of the body is exempt from the second source of impairment; that, namely, which consists in the natural death or deterioration of the parts (independent of the death and decay of the whole body) after a certain period of their life. It may be proved, partly by demonstration and partly by analogy, that each integral or elemental part of the body is formed for a certain natural period of existence in the ordinary conditions of active life, at the end of which period, if not previously destroyed by outward force or exercise, it degenerates and is absorbed, or dies and is cast out; needing, in either case, to be replaced for the maintenance of health." To these weighty words we may lastly add the opinion of Dr. Carpenter, who remarks that, "when the adult type has once been completely attained, every subsequent change is one rather of degeneration than of development, of retrogression rather than of advance."

Degeneration is thus an invariable concomitant of life. So far

from being in any way an abnormal phase of living action, it is seen to be as natural a process for living beings to retrogress—wholly, as we have seen in some cases, or partly, in others—as it is for them to develop and advance. And what is thus undoubtedly true of the individual man or other animal is no less so of the race. "Buried civilizations" are by no means unknown; extinct culture is an archæological fact; the decline and fall of nations are matters of history. May not these things be likewise explained as a part of that wide theory of life which regards even the highest interests of man as lying within the operation and sway of causes which mold his physical organization? If this notion be accepted, then is the idea of degeneration as a normal phase of life rendered still more feasible and plain. Reaching to the individual and to the species as well; extending and including in its scope the lowly organized as well as the higher being; affecting one group or class lightly, and influencing another wellnigh to the complete exclusion of progress, we find degeneration and retrogression to be numbered among the stern realities of existence. And no less clearly and forcibly may we trace the truly natural place of degeneration in our own physical history: since, as physiology teaches and daily experience declares, not an action is wrought or a thought conceived without the presence of change and decay of tissue—a process this which, limited in early life by progressive growth and by development, at last comes in our latter days to assume the reins of government, and in time to dissipate our energy and substance into the nothingness of physical and corporate extinction.

The philosophy of biology, however, may, in conclusion, be found to point out to us that the subject of degeneration, while treating of a powerful factor in modifying the living form, yet possesses a favorable aspect in relation to progress and evolution. High authority in matters biological may be found for the statement that degeneration is really a result of progress, that it is dependent on high development, and that, while it simplifies the living being, "it produces the same effect as differentiation, for it leads to variety in form." Thus there is a kind of evolution and progress inseparable even from degeneration itself. For the retrogression may in itself lead to variety and change, and in due time such variety may be the starting-point of new and higher developments. So, likewise, we are reminded that reduction and degeneration of some parts may proceed contemporaneously with the higher development of others, with the total result of perfecting the organism and of evolving a higher type of structure. The degeneration of a frog's tail is in reality a feature of its higher type as compared with its tailed friends, the newts and salamanders. The disappearance and reduction of the tail which the young crab possesses is a chief reason why we esteem the crab, whose body is all head and chest, a higher animal than the lobster or prawn, with head, chest, and tail complete. The degeneration of the "outside" gills of the Alpine

salamander's young, which never have access to water, is not a mark of inferiority but of superiority ; it is, in reality, the casting off of the old or larval and aquatic characters and the putting on of the new and higher features of the land-animal. Even the degeneration of human structures—the modification of the tail which early human existence exhibits, and of muscular structures well developed in lower life—are no proofs of inferiority, but are evidences of superiority in ourselves. Thus, even in the great work of evolving higher races out of the lower, to degeneration much is owing for its aid in repressing larval characters and the structures which belong to lower existences. While progressive evolution develops the great tree of life, extends each branch, clothes it with verdure, and expands each blossom, it is degeneration which lops the worn and aged stems, prunes the weakly foliage, trims the budding growths, and so directs and molds the outlines of the organic whole. It is to evolution and progress that the world of life largely owes its forward march. But hardly less is the debt of gratitude due by the living hosts to degenerative change and retrogression which, though stern and ofttimes cruel in their ways, nevertheless mark wisely and well the pathways of life, and prevent the useless and weak from cumbering the ground.—*Gentleman's Magazine.*

THE PHENOMENA OF DEATH.

By THOMAS D. SPENCER, M. D.

THERE seems to be no subject from which the mind so instinctively shrinks, few thoughts more repellent to the soul, and no dread vision of the night, howsoever fantastic it be, that presents to the imagination so formidable an aspect as that of death. Indeed, with this all nature seems at variance. The English ivy creeping over fallen ruins, or the fresh moss covering the prostrate trunk of some forest oak, seems as if endeavoring to hide from view the havoc which death has made. Beyond the merely instinctive desire to exist, the dread of death is a matter of education. Never does the child forget his first sight of a corpse ; the darkened chamber, the storm of grief, the white face and rigid features, all combine to form an indelible impression on the mind.

It is probably the extensive paraphernalia attending the funeral of the present day that render death so formidable. In war—on the battle-field, where death assumes its most sanguinary aspect—the mind of the soldier, from constant association, becomes so inured, that it ceases to be impressed with natural terror, and death seems but another foe to be met and conquered. Although the consideration of this topic be repugnant to the naturally healthy mind, there

come times in the life of every individual, that might be termed periods of self-consciousness, during which the mind brushes aside the more vulgar affairs of life, and grapples with the awe-inspiring mysteries of death. As these phenomena are considered one after another in their manifold aspects, the mind, owing to the association of ideas, becomes involved in such an intricate labyrinth of thought, that, after wandering here and there, vainly endeavoring to solve the problem of death, it gives it up as a hopeless conundrum.

It is our purpose to discuss, as briefly as possible, some of the most important aspects of dissolution.

Addison said that there was nothing in history more imposing than, nothing so pleasing and affecting as, the accounts of the behavior of eminent persons in their dying hours; and Montaigne remarks, while speculating on death, that of all the passages in the annals of mankind those which attracted and delighted him most were the words and gestures of dying men. "If I were a maker of books," he continues, "I would compile a register with comments of various deaths, for he who should teach men to die would teach them to live." There are three elements presented in this fear of death: First, the extinction of life's pleasures, interests, and hopes, to which the mind looks forward with a degree of apprehension, proportionate to the amount of happiness they are capable of affording. With the young and vigorous the loss of these animal enjoyments is contemplated with extreme misery; hence the custom, among the early Greeks, of bearing the lifeless body of youth to the funeral-pyre at the break of morn, "lest the sun should behold so sad a sight as the young dead." Second, the dread of the unknown future, also depending upon the nervous temperament. And, lastly, comes a fear more powerful than either, which is the dread of pain, inherent in nature. From time immemorial the actual moment of dissolution has been supposed to be accompanied by a throe of anguish known as the "death-agony." This is believed to occur at that moment when the spiritual and physical forces that have been so intimately blended for many years are torn asunder, the one to molder and decay, the other to take upon itself that new life beyond the ken of man.

This last element properly belongs to the physiologist, and as such we propose to consider it. Sir Francis Bacon, in one of his essays, published for the first time in the year 1577, gave to the world the following profound thought: "It is as natural to die as to be born, and to the little infant, perhaps, the one is as painful as the other." In profundity of thought and depth of research Bacon stepped in advance of his contemporaries, and lived in the future. Thus we find that, contrary to the generally received opinion of even this latter day, Nature evidently designed that the end of man should be as painless as his beginning.

At birth the babe undergoes an ordeal that, were he conscious,

would be more trying than a most painful death ; yet he feels it not. Born in an unconscious state, the brain incapable of receiving conscious impressions, his entrance into this hitherto unknown world is accomplished during a state of oblivion, known as Nature's anæsthesia :

"Painlessly we come, whence we know not—
Painlessly we go, whither we know not!"

From the earliest period of human history death has been considered as necessarily accompanied by pain ; so general is this belief, that the terms "death-agony," "last struggle," "pangs of death," etc., have been in almost universal use in every age and under all conditions of society.

Nothing could be more erroneous ; the truth is, pain and death seldom go together—we mean the last moments of life. Of course, death may be preceded by weeks or even months of extreme suffering, as occurs during certain incurable diseases.

So exaggerated has been this notion that it has been considered an act of humanity to anticipate the "death-struggle" by violence ; for ages it was customary among the lower classes of Europe to hasten death by suddenly jerking the pillow from beneath the head of the dying, thus throwing the head backward, straining the pharyngeal and thoracic muscles, rendering the respiration, already difficult, shortly impossible. A Venetian ambassador, in the time of Queen Mary, asserted that it was a common custom among the country-people to smother the dying by means of a pillow placed over the face, upon which leaned or sat the nearest relative. This was founded upon the pious belief that a short road was the best one. This custom was handed down from generation to generation, parents performing it for their children, and *vice versa*. But, perhaps, the saddest privilege ever allowed the near friends of a dying man, occasionally occurred during the reign of Queen Elizabeth, when through executive clemency—in executions by hanging—they were permitted to grasp the feet of the suspended criminal, and, by clinging to the extremities, precipitate their additional weight on the body, thereby hastening strangulation. It is needless to say that these theories are false in both conception and practice. Death is a physiological process, and like all other animal functions should be painless.

When the fiat of death went forth, Nature kindly provided an anæsthetic for the body. As the end of life draws near, the respirations become slow and shallow, interrupted now and then by a deep, sighing inspiration, as though the lungs were vainly endeavoring to throw off the palsy creeping over them. As the intervals between the inspirations grow longer, the blood becomes saturated with carbonic-acid gas—the same as that formed from burning charcoal, whose deadly fumes have so often aided the suicide to painlessly destroy life.

While the power of breathing is gradually failing, the heart, which

is in close sympathy with the lungs, begins to contract with less force, propelling the blood only a short distance through its arterial channels, thus causing the extremities to grow cold.

The blood sent to the brain is not only diminished in quantity, but is laden with carbonic-acid gas, which, acting on the nervous centers, produces a gradual benumbing of the cerebral ganglia, thereby destroying both consciousness and sensation. The patient gradually sinks into a deep stupor, the lips become purple, the face cold and livid, cold perspiration (death-damp) collects on the forehead, a film creeps over the cornea, and, with or without convulsions, the dying man sinks into his last sleep. As the power of receiving conscious impressions is gone, the death-struggle must be automatic. Even in those cases where the senses are retained to the last, the mind is usually calm and collected, and the body free from pain.

"If I had strength to hold a pen, I would write how easy and delightful it is to die!" were the last words of the celebrated surgeon, William Hunter; and Louis XIV is recorded as saying with his last breath, "I thought dying had been more difficult."

That the painlessness of death is due to some benumbing influence, acting on the sensory nerves, may be inferred from the fact that untoward external surroundings rarely trouble the dying.

On the day that Lord Collingwood breathed his last, the Mediterranean was tumultuous; those elements which had been the scene of his past glories rose and fell in swelling undulations, and seemed as if rocking him asleep. Captain Thomas ventured to ask if he was disturbed by the tossing of the ship. "No, Thomas," he answered, "I am now in a state that nothing can disturb me more—I am dying; and I am sure it must be consolatory to you, and all that love me, to see how comfortably I am coming to my end." In the "Quarterly Review" there is related an instance of a criminal who escaped death, from hanging, by the breaking of the rope. Henry IV of France sent his physician to examine him, who reported that after a moment's suffering the man saw an appearance like fire, across which appeared a most beautiful avenue of trees. When a pardon was mentioned, the prisoner coldly replied that it was not worth asking for. Those who have been near death from drowning, and afterward restored to consciousness, assert that the dying suffer but little pain. Captain Marryat states that his sensations at one time when nearly drowned were rather pleasant than otherwise. "The first struggle for life once over, the water closing round me assumed the appearance of waving, green fields. . . . It is not a feeling of pain, but seems like sinking down, overpowered by sleep, in the long, soft grass of the cool meadow."

Now, this is precisely the condition presented in death from disease. Insensibility soon comes on, the mind loses consciousness of external objects, and death rapidly and placidly ensues from asphyxia.

In spite of the natural antagonism to death, a moment's reflection will show that it is as much a physiological process as life; the two terms are correlative, the degree of vital activity depending on the extent of molecular death occurring at the same time. Strange as the paradox may seem, without death we can not live: every thought emanating from the brain, every blow struck by the arm, is accompanied by destruction of nervous or muscular tissue. The bioplasmatic or living matter of Beal, which enters into the formation of every animal tissue, is constantly germinating into cells (the origin of all life), and as constantly passing into decay, their places being taken by other protoplasts, thus keeping up the "active dance of life."

This disassimilation or interstitial death occurs to such an extent, that Nature, in her wisdom, has provided excrementory organs for the purpose of removing from the system the effete material thus produced. Every living structure, after passing through certain stages of development, maturity, and finally retrogression, must come to an end. This may be but the ephemeral existence of some of the lower forms of fungi, which, born in the cool of the morning, die as the sun goes down; or, like the famous dragon-tree of Teneriffe, may outlast the Pyramids that keep watch by the Nile.

The last topic for consideration is the *pseudopia* of death, or visions of the dying. This subject, coming under the realm of mental science, properly belongs to metaphysics rather than to physiology. Various theories have been advanced to explain these phenomena, but they must remain as hypotheses at best, for they are not susceptible of demonstration. It is not an uncommon occurrence for the dying, after lying some hours in a semi-conscious condition, to start up suddenly, and, with glowing face, point eagerly to some object invisible to the bystanders, and with animated voice and gesture state that they behold the glories of heaven, or the familiar countenance of some friend long since dead.

The question naturally arises as to whether these visions are merely the fantasies of a disordered and fast-disorganizing brain; or are the dying actually permitted a momentary view of those mysteries hitherto unknown?

The traditions and superstitions of the past have led to a popular belief in the latter theory. Shakespeare expressed the sentiment of his day when he placed in the mouth of the dying Queen Katharine these words:

> "Saw you not even now a blessed troop
> Invite me to a banquet, whose bright faces
> Cast thousand beams upon me like the sun?"

Science, with its iconoclastic hand, has swept away these pleasing fancies, and in their places has constructed a fabric founded on analo-

gy. In the anæsthesia induced by chloroform, a condition is produced closely resembling that immediately preceding death (caused by the carbonic-acid poisoning), in which visions are constantly presented to the mind, the character of which depends upon the natural temperament of the individual. Thus it often occurs that a patient, when under the influence of chloroform, has beatific visions similar to those of the dying. It is my fortune to have at present a patient who invariably, when under the influence of chloroform, asserts that she sees angels hovering round her bed. The impression is so strong that she becomes much annoyed if the reality of these visions is disputed. The asphyxia produced by burning charcoal is ofttimes accompanied by disturbed fancies, similar to those preceding death, and the natural inference is that they are the resultant in both cases of one and the same cause. During the last moments of life, the mind gradually loses cognizance of external surroundings, and is rapt in self-contemplation. Though still in a semi-conscious condition, the weeping of friends and the voices of attendants fall upon dull ears. The eyelids are closed, the pupils slightly contracted, and rolled upward and inward. The dying man has forgotten the present, for he is living in the past. One by one the events of a whole life appear, its joys and sorrows, perchance long since forgotten, rise before him in startling distinctness, and then disappear in the swiftly moving panorama. The familiar faces of the friends of his youth are thrown upon the mental retina, their cheery voices reverberate in his ears, and the thought of meeting these friends in the near future is perhaps his last conscious impression. As this drowsiness creeps over the system, these images, molded from the past, become as realities to the disordered imagination. The germs from which originate these strange combinations have probably been lying dormant for years in the registering ganglia of the brain.

Dreams never surprise us, no matter how strange the scenery presented, or how great the violation of truth and reality: so it is in this last great vision of life. What wonder that a dream so vivid should be carried into action? The brain, with a convulsive effort, sends the message through the system, the muscles spring into activity, and the dying man, with outstretched arms, calls the attention of the awe-stricken bystanders to these fantasies of his own brain. Thus some pass away as though falling asleep; others with a sigh, groan, or gasp; and some with a convulsive struggle.

These death-bed visions are comparatively of frequent occurrence, and are generally accepted as realities. The theory which we promulgate, though not new, will naturally excite prejudice; but it is better to know the truth than to cherish a belief, however pleasing it be, founded on error.

UNION OF THE TELEGRAPH AND POSTAL SERVICE.

By ALDEN B. HUET.

THE recent consolidation of competing lines of telegraph into one gigantic corporation, and the consequent agitation of the question of Government control by the public press, Boards of Trade, and in Congress, make an inquiry into the subject of postal telegraphs, at the present time, of unusual interest.

In determining the question as to whether the United States should constitute this means of communication a part of the general postal system, the first important consideration is, whether such action is authorized by the Constitution; secondly, whether such control has proved a success in the several countries where it is thus organized; and, finally, whether a beneficial re ılt is likely to follow from similar action in this country.

As to the first proposition, there can be no doubt. That clause of the Constitution wherein this authority is granted is found in section 8 of Article I, in this language: "Congress shall have power . . . to establish post-offices and post-roads." By this comprehensive and explicit declaration, the framers of the Constitution, without doubt, intended to lodge with the General Government the exclusive privilege of regulating and conducting the transmission of intelligence among its citizens—in other words, the intent was to give to the General Government the exclusive monopoly of the postal service, by which was meant the interchange of intelligence, not only by the methods then in use, but also by the use of improved methods thereafter devised and adopted. This opinion is sustained by the decision of the Supreme Court in the case of The Pensacola Telegraph Company *vs.* The Western Union Telegraph Company (6 Otto), in which the Court says: "Post-offices and post-roads are established to facilitate the transmission of intelligence. Both commerce and the postal service are placed within the power of Congress, because, being national in their operation, they should be under the protecting care of the national Government." That these views are sound is too plain to be doubted. Continuing, however, the Court touches upon the very point in question—the telegraph: "The powers thus granted are not confined to the instrumentalities of commerce, or of the postal service, known or in use when the Constitution was adopted; but they keep pace with the progress of the country, and adapt themselves to the new developments of time and circumstances. They extend from the horse with its rider to the stage-coach, from the sailing-vessel to the steamboat, from the coach and steamboat to the railroad, and from the railroad to the telegraph, as these new agencies are successively brought into use to meet the demands of increasing population and wealth. They were

intended for the Government business to which they relate, at all times and under all circumstances.". It was impossible for the men who framed the Constitution to foresee the wonderful improvements in the means of rapid intercommunication which have since taken place. At that time there were only a few post-roads in the United States, and over these the mails were conveyed on horseback or in the stage-coach, consuming a fortnight in the trip from Boston to Philadelphia, that is now made by the fast mail in a few hours. In the progress of events, the people demanded a quicker means of communication, and the Government did not hesitate to place the mails upon the railroads as fast as they were constructed. Now, in many instances, the railroads are too slow to meet the demands of business communication, and the telegraph is freely used in all important commercial transactions. The business-man who does not use the telegraph each day for information as to markets abroad, to make contracts with distant customers, to transmit money, and in various other ways, is counted slow indeed in this age of progress. From these facts, is there not the more reason for making this wonderful and powerful agency subservient to the general postal system of this great and growing country than there was for providing for the carriage of the mails by steam?

Further, it is not only a constitutional privilege, but it is also a constitutional duty; and it is susceptible of the strongest proof that, in neglecting to make the telegraph a part of the postal system, the Government has failed of its constitutional duty toward its citizens. Such powers as are granted to the General Government are granted absolutely, and are lodged nowhere else. In the language of the tenth amendment, "The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people." It may not be improper to observe here that only such powers were granted to the General Government as could not properly be exercised by the States. For instance, the right to declare war was granted to the General Government, and wisely, else New York might declare war against some foreign power, while the remaining States might be strongly in favor of peace. It is, therefore, fair to infer that such powers as were granted to the General Government were not "reserved to the States respectively, or to the people"; and in this class, as we have seen, is the power to regulate and control the transmission of intelligence. In the language of Mr. Justice Field, in *ex parte* Jackson (6 Otto), "The power possessed by Congress embraces the regulation of the entire postal system of the country." It extends to the telegraph as well as to the railroad, and the conveyance of letters and packets by regular trips over railroads by private parties is prohibited by law (Revised Statutes, sections 3,982, 3,983), yet we permit a private monopoly to convey our messages the quicker way by telegraph. The Government enforces a monopoly of the transmission of intelligence by the slower methods,

but when the lightning is invoked that is left to the monopoly of a single private corporation, contrary to the true intent of the Constitution.

Let us now see what success has attended the postal telegraphs of other countries, which have been quick to shed the blessings of an American invention upon their citizens, under the protection afforded by Government control. Among the first to adopt this system was the Government of Belgium, where, March 15, 1851, it was established with a tariff of two and one half francs for twenty words within a radius of seventy-five kilometres, or fifty cents for a distance of forty-six and one half miles, and five francs for a distance above seventy-five kilometres. The "registered system" was adopted here by which the sender, upon payment of a double fee, was provided with an exact copy of the message delivered to his correspondent, together with the exact time of the delivery. In 1878 the tariff had been reduced to a fraction over eight cents for each twenty words, and the receipts from this source amounted to $426,258.84. The next year, December 5, 1852, Switzerland adopted the system with the following tariff: for a message of twenty words, one franc; over twenty and under fifty, two francs; above fifty, three francs. In this country, almost from the very first, the receipts showed a large surplus over expenditures, and this was augmented in 1868, when the tariff was reduced to one half a franc for twenty words—a uniform rate. In 1879 the receipts amounted to $400,763.04; expenses, $314,893.39. About the same time the system was introduced in France, where it proved a complete success from the first. In 1877 the French tariff was a fraction over sixteen cents for twenty words, and the receipts from this source were $3,203,800. Then followed Russia, Germany, Sweden, Italy, New Zealand, and other countries, with the most gratifying results in each case. Great Britain, usually so quick to adopt reforms in the postal service, and to which Government we are indebted for various improvements in our service—the postage-stamp, money-order, postal-car, carrier-system, postal-card, etc.—was the last of the European countries to establish the system. Previous to its introduction there, the Chambers of Commerce memorialized Parliament in favor of the measure, alleging that they "had reason to complain not only of the high rates charged by existing companies for the transmission of messages, of frequent and vexatious delays in the delivery, and of the inaccurate rendering, but that many important towns, and even whole districts, are unsupplied with the means of telegraph communication." In moving leave to introduce the postal telegraph bill, the Chancellor of the Exchequer said: "We were in the habit in this country of leaving to private enterprise the administration of internal affairs, the exception to the rule being that of postal communication. With the consent and approbation of the country, this was a monopoly in the hands of the Government; and he submitted that telegraphic com-

munication and postal communication might be considered as coming within the same category, as both provided for correspondence between persons at a distance, and the only difference was the mode of communication. It would be admitted, as a general principle, that the monopoly which had succeeded so well in regard to the conveyance of letters might be expected to succeed equally as well in a more rapid method of communication. He was not aware of monopoly in the one case which would not hold good in the other." The reasoning of the distinguished Chancellor applies with greater force to this country, where the rates are higher than they were at this time in Great Britain, and where the entire telegraph system is in the hands of a single private corporation. The transfer of the telegraph business to the Government in Great Britain took place February 5, 1870, and in 1872 there was a net revenue from this source of £159,835, which increased in succeeding years. The following table exhibits the extent of telegraph business in the countries named:

COUNTRY.	No. of telegraph-offices.	Length of lines (miles).	Receipts.	Year.
Great Britain	5,254	115,460	£1,346,892	1879
France	2,895	35,445	$3,203,800 00	1878
Russia	2,166	59,012	3,046,539 08	1874
Switzerland	1,150	.....	400,763 04	1879
Belgium	586	3,234	426,258 84	1878
Italy	1,795	14,750	1,451,088 64	1875

The conclusions deduced from the foregoing facts, as applied to the question of adopting such a system in this country, are:

1. That the Government has the constitutional right to own and operate lines of telegraph, as a part of the general postal system, to the exclusion of all private competition; and, further, that such action is clearly a constitutional duty.

2. That in all the leading countries of the world the Government exercises this right, either in whole or in part, to the great benefit of the citizens of such countries, protecting them from the extortions of monopolies, and guaranteeing, for a small charge, to transmit and deliver their telegraphic correspondence with the privacy of sealed letters, with greater certainty and efficiency than can be assured by private corporations.

3. That there is no reason to doubt that the success which has attended the system in other countries would obtain here, especially when we consider the energy and enterprise of our countrymen, and the extent and resources of our great and rapidly developing country; and that with a uniform tariff, say of twenty cents for twenty words or less, it could be made in a few years to cover all expense, if not (which is probable) a source of revenue to the Government. That the near future will witness this realization is quite certain.

SKETCH OF DR. CHARLES T. JACKSON.

THE name of Dr. CHARLES T. JACKSON deserves to be awarded a prominent place in the annals of American science. It is closely associated with the earlier geological investigations in the United States and the British Provinces, and with the initiation of discoveries which have contributed immensely to the increase of the economical resources of the world and to the amelioration of the pains of suffering men. However the balance of merit in the discovery of the electro-magnetic telegraph and of anæsthesia may be awarded, the fact that Dr. Jackson conceived the ideas which embody the principles of those discoveries, and probably imparted them to the more practical men who made them known to the world, can hardly be disputed.

Dr. Jackson was born at Plymouth, Massachusetts, June 21, 1805. Having studied medicine under Drs. James Jackson and Walter Channing, he entered the Medical School at Harvard University, and received its degree of Doctor of Medicine in 1829. He had already manifested an inclination toward other studies than those required in the practice of medicine, and became particularly interested in chemistry, mineralogy, and geology. Indeed, before receiving his degree, he explored, in company with his friend Mr. Francis Alger, a considerable part of the province of Nova Scotia, and made there a large collection of minerals; these being new to foreign cabinets, he was able, by means of exchanges with them, to form for himself a cabinet of great value.

Soon after receiving his degree he went to Europe to complete his studies, where he remained for three years. At Paris, he became acquainted with many eminent men, among them the celebrated geologist, Élie de Beaumont, with whom he formed a warm friendship that continued through life. In 1831 he made a pedestrian tour of a large part of Central Europe, visited the principal cities of Italy, and made a geological tour of Sicily, and of Auvergne, in France. It was while returning from his European residence, in October, 1832, having electro-magnetic, galvanic, and other philosophical apparatus with him, that he had those conversations with Professor Morse which he claims implanted in that inventor's mind the germs of the idea of the electro-magnetic telegraph. A year and a half afterward, in the spring of 1834, as he asserts, he constructed, successfully worked, and exhibited to his friends, a telegraphic apparatus similar to that the conception of which he claimed to have described to Professor Morse.

He settled in Boston, in the practice of medicine, in 1833, but in a short time abandoned his profession, so that he might give his whole time to the chemical, mineralogical, and geological investigations which he preferred. He soon became known as one of the leading

scientific men in the country. He was appointed State Geologist of Maine, and surveyor of the public lands of Massachusetts lying in Maine, in 1836, and spent three years in the execution of those works. In 1839 he, as State Geologist, surveyed Rhode Island; and he began the geological survey of New Hampshire, in which he was occupied for three years, in 1840. At about this time he drew up a plan for the geological survey of New York, which was adopted. He explored the southern shores of Lake Superior, and revealed the mineral resources of that country in 1844; returned to the same region in the next year, and opened copper-mines, and discovered iron-mines. In 1847 he was appointed to superintend the geological survey of the mineral lands of the United States in Michigan, a work in which he continued for two years, till he was displaced in consequence of political changes in the national Government. He became a member of the Boston Society of Natural History soon after its formation, and was elected one of its curators in 1833. He afterward became one of its vice-presidents, and continued to hold that office till disabled by sickness in 1874.

Dr. Jackson's name is most closely associated with his claim to priority in the discovery of the anæsthetic properties of ether, which was the subject of a long controversy, and one that was very painful to him. His claim is supported by the testimony of Mr. Francis Alger, Dr. J. B. S. Jackson, Dr. Martin Gray, and Mr. T. T. Bouvé, to whose eulogy before the Boston Society of Natural History we are indebted for most of the facts given in this notice. These gentlemen were his chosen friends, and were for a long time closely associated with him. Dr. J. B. S. Jackson was one of the signers of a remonstrance addressed to Congress against its making a grant of money to W. G. Morton, Dr. Jackson's rival in the claim of discovery, based upon the ground that the signers believed that the reward, so far as the question of discovery was concerned, ought to go to Dr. Jackson. Dr. Martin Gray published a pamphlet under his own name, maintaining that Dr. Jackson was the sole discoverer of anæsthesia, and that Mr. Morton could only be considered to have performed a secondary part by proving that the administration of ether is safe in surgical operations. Mr. Bouvé, who was for a considerable time a student in Dr. Jackson's laboratory, and afterward met him frequently in social intercourse, accords to him the honor of having been the discoverer of the anæsthetic properties of ether, but has "never thought him entitled to the credit of its introduction into use, or even to that of having thoroughly verified what he claimed to be true respecting the safety of administering it. He had experimented upon himself, and had afterward demonstrated respecting it, even going so far as to recommend its use by others, and this constituted discovery; but he did not prove to others what he was himself convinced of, and allowed precious time to pass—yes, much time—without making any application of the discovery. Indeed, had it not been that Mr. Mor-

ton sought from him means to prevent pain when extracting teeth, it is doubtful if the world would have had the advantage of the discovery for years, if ever. The truth is, Dr. Jackson was a great genius and had remarkable intuitive perceptions of scientific truths, but, from some peculiarities hard to comprehend, he often contented himself with enunciating what he recognized as fact, without striving to substantiate it. He himself admitted his shortcomings in this respect. When Dr. Gray had written his essay upon the discovery of ether, claiming for Dr. Jackson all the merits of its introduction, I objected to his view of the matter, and took the ground that the world was indebted to both Jackson and Morton for the great boon; to one as the scientific discoverer and suggester of its use in surgical operations, to the other for his application of it and its practical introduction.

"Dr. Jackson, learning of this, upon meeting me remarked that I was thought not to be friendly to him in the matter. I then said: 'Doctor, you have known for a long period what Mr. Morton is now demonstrating to be true, but have allowed it to remain a dormant fact in your mind. If he had not sought information from you, might it not have remained so for years longer?' He answered that possibly it might. I think it may fairly be said that, without both Jackson and Morton, the world might have been none the happier for what either would have done; one supplemented the other. To them together belongs the great honor of having served humanity beyond what language can express."

Dr. Jackson was the first person in this country to establish a chemical laboratory for students; and many of the chemists of the last half-century were indebted to him for their earlier instruction in the analyses of mineral bodies. While engaged in giving instruction of this kind, he invented a powerful blast-lamp for alkaline fusions, which was very serviceable previous to the introduction of street-gas into laboratories.

His geological explorations of the three New England States and the south shore of Lake Superior were among the earliest that were made in the United States.

Dr. Jackson's scientific papers, which appeared from time to time in the public journals, were numerous; many of them were of great interest and importance.

As early as 1834 he contributed to the "Journal of the Boston Society of Natural History" an article on the "Chiastolite or Macle of Lancaster, Massachusetts." This was followed by other papers on various minerals. The published "Proceedings" of the Society, from 1841 till the time when he was prostrated by illness, were illuminated by his frequent contributions to the discussions and papers on matters of scientific interest. To "Silliman's Journal" he contributed "Analyses of the Mineral Waters of the Azores"; "Remarks on the Geology

of Maine"; "Bituminization of Peat, and its Conversion into Coal"; "An Account of the Catlinite or Indian Pipe Quarry"; "The Lava of the Volcano of Kilauea in Hawaii, and its Chemical Composition"; "Remarks upon Drift and upon the Organic Matters of Soils"; "The Lake Superior Copper Region"; "The Asphaltic Coal of New Brunswick"; "The Discovery of Fossil Fish in the Coal Formation of New Brunswick"; and a few papers of more limited interest.

To the "Proceedings" of the Association of American Geologists he has furnished descriptions of the veins of tin-ore in Jackson, New Jersey, and "Remarks upon the Zinc, Copper, and Lead Ores of New Hampshire." To the "Proceedings" of the American Association for the Advancement of Science, "Observations of a Mirage seen at Lake Superior"; "Remarks on the Geology, Mineralogy, and Mines of Keneewaw Point"; "On Ancient Pot-holes in Rocks"; "Description and Analysis of Allanite from Franklin, New Jersey"; "Description of Bismuthic Tellurium from Virginia"; "On the Artificial Minerals from an Iron-Furnace in Pennsylvania"; and other papers. To the "Proceedings" of the American Academy of Arts and Sciences, "Remarks upon a Large Vein of Phosphate of Lime found in New Jersey"; "Analysis of Water"; "Analysis of Bornite from Georgia"; "Results of an Examination of the Frozen Well of Brandon, Vermont"; and "An Analysis of Meteoric Stone found in Dakota." To the Memoirs of the Academy he contributed, jointly with Mr. Francis Alger, a valuable paper on the "Mineralogy and Geology of Nova Scotia." Reports of analyses of soils made by him were published in the "American Quarterly Journal of Agriculture"; and he published in the "Boston Medical and Surgical Journal" an article on the existence of nitrogen in plants and its origin in animals. He also contributed to journals in Edinburgh; and to the "Comptes Rendus," of the French Academy, "Observations sur quelques mines des États-Unis et sur le grès rouge de Lac Supérieur"; "Courans Marines"; "Nouveau gisement de Trilobites"; "Sur les gisements d'or dans le Géorgie"; "Sur le Bornite de Dahlonega et sur les diamants de l'État de Géorgie"; and other papers. His more elaborate works are the three reports on the "Geology of Maine," published in 1837, 1838, and 1839; reports on the "Public Lands of Maine and Massachusetts" (1837 and 1838); the "Report on the Geology of Rhode Island" (1840); "Reports of the Geology of New Hampshire" (1841, 1842, 1844); "Report on the Mineral Lands of the United States in Michigan" (1849, with maps). He also published the results of chemical researches on the cotton-plant, the tobacco-plant, on Indian-corn, and on thirty-eight varieties of American grapes, which were embodied in the Patent-Office reports, and a "Manual of Etherization, with a History of its Discovery" (1863).

Dr. Jackson died on the 29th of August, 1880, after having suffered for many years from an affection of the mind.

EDITOR'S TABLE.

THE SCIENCE OF BIBLICAL CRITICISM.

A CHANGE is gradually coming over the meaning of the word *science*, or, rather, there is a growing appreciation of its true meaning, which is of great significance. In the newspaper column of "Science" we have a list of results of late experiments of all kinds. In looking over many scientific periodicals it would be inferred that the term is restricted to physical science. From the text-books we should conclude that science consists of the facts and principles that have been established and collected in different groups under this name. But it now begins to be understood that science properly means a method by which all these results are produced. It is a method of thought, a method of investigation, having for its simple object the establishment of the truths of nature. This method has grown up gradually in modern times to greater and greater perfection, and has widened in scope, until now it includes many subjects with which it was at first supposed to have no relation.

There has of course been great resistance to this tendency. For, while people admit that truth is valuable and precious, they generally think that they are also in full possession of it, and are, therefore, in little need of methods to arrive at it. Their beliefs are truth, and therefore not to be disturbed. Science doubts, with a view to reinvestigation, and is hence unwelcome. Especially where men band together in parties and sects and declare their opinions, there arises at once a spirit of hostility to any thorough inquiry which might unsettle the views to which they are committed. Meantime, in spite of this resistance, the spirit of investigation has gained strength and spread rapidly in all directions of research.

The latest and most impressive proof of the progress of the scientific spirit is seen in the recent treatment of the Christian Scriptures. Biblical criticism has long been affected by the scientific method, and is now to be controlled by it. How far the critical spirit is already advanced and diffused, so that the Bible is regarded as a book with a human and an imperfect side, and containing errors that can be removed with better knowledge, is shown by the fact that the English translation of two hundred and fifty years' standing has been lately attacked by a body of able and learned revisers, who, after eleven years of labor, have just given us a corrected edition of the New Testament. This is a great step in the direction of rationalism. It concedes that the Scriptures must be subjected to the tests of reason, and this concession is due entirely to the modern scientific movement, which demands higher standards of proof, and more inexorable questioning as to what is true.

The revisers of the New Testament have fairly and formally entered the critical wedge, but the driving it home is to be no holiday affair. Professor Robertson Smith, one of the most learned, able, and candid of Biblical critics, having undertaken to treat the history of some parts of the Old Testament in a great encyclopædia, was met by his church and silenced in his professorship in the Aberdeen University. But the world gains by this act of intolerance. Professor Smith left the college halls and went out to give a course of popular lectures upon the

critical history of the Bible, which were attended by crowds of eager listeners. The lectures are collected in a volume that at once becomes a text-book of modern Biblical criticism. The true scientific ground is here openly and broadly taken, and it is generally admitted that Professor Robertson Smith's book represents authoritatively the scope and objects and method of the critical school which has been growing during the last half-century. It has thus at length become the benign office of Science to bring its methods to the responsible task of throwing a better light on the origin, history, and true character of the Christian oracles than has been derived from uncritical tradition. Nor does the critical attitude taken by Professor Smith at all compromise his Christian position. He is no skeptic, trying to undermine the Scriptures. He holds to their essential truth, but recognizes that on earth and in time, and among ignorant, selfish, and prejudiced men, truth is liable to be obscured. Professor Smith is in no sense an enemy of the Bible, as the following passage from his lectures sufficiently attests. He says:

> The Bible is a book of experimental religion, in which the converse of God with his people is depicted in all its stages, up to the full and abiding manifestation of saving love in the person of Jesus Christ. God has no message to the believing soul which the Bible does not set forth, and set forth not in bare formulas, but in living and experimental form, by giving the actual history of the need which the message supplies, and by showing how the holy men of old received the message, as a light to their own darkness, a comfort and a stay to their own souls.

But a majority of the Free Church of Scotland think that this is insufficient, and demand that he shall cease his critical studies. A large minority, however, see plainly that it is neither possible nor desirable to arrest the great inquiry that is now so far advanced and so securely established.

A CASE FOR THE ANTI-VIVISECTIONISTS.

Of all the forms of hostility to science indulged in by narrow-minded, prejudiced people, the anti-vivisection movement is unquestionably the most ridiculous. Vivisection is cutting the living; surgery is, therefore, human vivisection. The human person is liable to a thousand accidents and diseases, which can only be relieved by vivisection. The surgeon, with his cutting instruments of innumerable shapes, operates boldly upon the living system, inflicting pain that pain may be relieved, saving damaged organs, restoring health, and prolonging life. There is, indeed, no art practiced by man that is so valuable and important as that of human vivisection—and this, moreover, everybody knows.

But human vivisection, pursued for its beneficent purpose, is a difficult and dangerous practice. It requires the most accurate and thorough knowledge of the organization of the human body, and extensive experience in working upon it. In its early stages, when little was known of the living system, it was a dreadful barbarism, a manipulation of torture, and, in serious cases, more liable to injure than to benefit. The province of surgery has ever depended upon knowledge and experience, and it has become successful in proportion as knowledge has increased and the opportunities of practice have been enlarged. Modern surgery has advanced with the most rapid strides, and at every step has made humanity its debtor. And this, also, everybody knows.

Yet, from the beginning, men have combined to hinder the development of this art upon which so much of human welfare depends. For thousands of years the dissection of the dead human body—the only source of knowledge to the surgeon—was held a horrible thing by the multitude, was denounced as sacrilege by the Church, and was forbidden by the state.

In recent times it has been discovered that there is a unity of method and law running through all forms of organic life, such as was never suspected in former ages. This was a great step in the progress of science, and a great opening for the physician and surgeon, as the whole realm of inferior life was at once made tributary to the development of the physician's art—that is, the human vivisector, who had been hitherto greatly cramped and embarrassed by the difficulties and limited scope of his operations, could now carry on his inquiries more thoroughly and comprehensively by experiments upon the lower animals. It was a grand possibility, and, broadly considered, forms the most important step in the progress of medical and surgical science and art.

But, here again, ignorance and prejudice have, even in our day, combined to hinder the use and extension of knowledge vital to human benefit. As the human body was once forbidden to be dissected, so now it is forbidden to vivisect the lower animals. Anti-vivisection societies are formed, and anti-vivisection legislation is sought and has been obtained to defeat the work of the experimental physiologist. The anti-vivisectionists express great sympathy for the poor dumb animals, and assume to be their protectors. The sympathy is commendable, the function assumed a most proper one, and the field for the exercise of both boundless, so that these friends of the suffering animals can exhaust all their energies in protective work, without meddling with the physiologists.

But these stupid zealots deny that there is any use in vivisection, or that any good has ever come from it. They profess to know more about the matter than the physiologists and surgeons, and demand that Government shall stop the practice entirely. We have now a fresh illustration of what it it is that they would suppress. A malignant case of cancer of the stomach, such as have hitherto resisted all remedies, has been cured by a surgical operation which could never have been successfully performed but for long apprenticeship in vivisection. A large fibrous cancer had grown over the pyloric orifice of the stomach through which the food passes into the intestine, which was nearly closed, and must soon have killed the patient. The stomach was opened, the cancerous tumor removed, a new orifice prepared, the intestinal tube sewed fast to the stomach, and the patient recovered. The operation was performed by Professor Theodor Billroth, of Vienna, and his account of it was translated by the United States Minister to Austria, Hon. John A. Kasson, and sent to the "New York Tribune," from which we copy it. Professor Billroth says:

The removal of the frequently occurring carcinoma of the stomach, against which all internal remedies have been applied in vain, by the aid of surgery, has long been the subject of debate. Seventy years ago, a young physician, Karl Theodor Merrem, published a pamphlet in which he demonstrated, by experiments made upon three dogs, two of which survived the operation, that it was possible to cut out the pylorus and to join the duodenum with the stomach. He went even so far as to propose this operation in cases of human beings suffering with incurable carcinoma of the pylorus. In those days the conviction that the processes of life, their interruption and their equalization, were essentially the same in the human body and that of animals, had not obtained sufficiently, nor had the operative technique advanced far enough to cause the significance of these experiments to be fully appreciated and to render the application of the physiological result upon the human body possible. The best surgeons of France, England, and Germany have in the course of this century discussed the best methods of joining wounds of the stomach and the intestines. Since the discovery by Lembert of the only true principle upon which this operation can be carried out successfully, satisfactory results became of more frequent occurrence. But the excision of diseased parts of the intestines was not attempted until about ten years ago. In 1871

I demonstrated the possibility of cutting out sections of the œsophagus in large dogs, and that the wound healed, leaving the œsophagus slightly contracted but easily to be dilated. Czerny was the first to carry out this operation successfully upon a human being. His experiments to extirpate the larynx led to my successfully removing a human larynx obstructed by a cancerous growth. In 1877 I succeeded in performing the operation of gastroraphy, which proved that no anxiety need be entertained as to the gastric juices of the stomach interfering with the scar-tissue so as to bring about its solution.

I have stated this for the benefit of those who are of the opinion that my operation is a reckless experiment on a human life. Such an opinion can not be entertained for one moment. The operation of cutting out parts of the human stomach has, like any other new operation, been prepared anatomic-physiologically and technically by myself and my assistants. Every surgeon, having any experience in experiments on animals, and similar operations upon the human body, arrives at the conclusion that this operation must and will succeed. Pean, the Paris surgeon, was of the same opinion. He attempted the removal of a cancerous pylorus, about six centimetres in diameter, in the case of a patient very much reduced by suffering, and who died four days after the operation. His method of operating, and especially his choice of catgut as sewing material, did not seem to me a good one. He has not attempted to repeat the operation, so far as I know, and no other surgeon has ventured to undertake this by no means easy task.

CUTTING A CANCER FROM THE STOMACH.

The few cases which came under my notice in the course of the past year did not seem to me to be proper ones for a first operation of this kind. It was only recently that the case of a woman was presented to me where the diagnosis of a cancerous pylorus was certain. After a few days of observation, the patient assenting, I made up my mind to undertake the operation. The woman, about forty-three years of age, and mother of eight children, was taken sick—very suddenly, it would seem—in October, 1880, with vomiting. The symptoms of cancer of the stomach with stenosis of the pylorus soon showed themselves. The only thing she was able to retain for any length of time was sour milk. The preparations for the operation consisted in accustoming the patient to peptonized injections, and the cleansing of the stomach by the well-known method of injection and pumping. The room, specially prepared for the occasion, was heated to 24° Réaumur, and the narcotic administered by one of my assistants, every one of whom seemed to be conscious of the importance of the undertaking. No interruption and not a minute of unnecessary delay occurred. The movable tumor, lying a little to the right, seemed to be of the size of an ordinary apple. A diagonal incision about eight centimetres long was made over the tumor, which proved to be a knotty and infiltrated cancer of the pylorus, occupying more than a third of the lower portion of the stomach. Separation of the adhesion to the omentum and the transverse colon followed; then the division of the large and small omentum. Every vessel was tied before being cut, the loss of blood being very small. The tumor was turned out over the abdominal walls, and a cut was then made through the stomach, one centimetre beyond the infiltrated part, at first only backward, then in the same manner through the duodenum. The attempt to put together the edges of the cut parts showed the possibility of joining them. Six stitches were taken through the edges, but the threads were not yet tied, and only used to retain the edges in position. A further cutting through the stomach was then made diagonally from the upper and inner to the lower and outer side, but always at a distance of one centimetre from the infiltrated portion of the coating of the stomach. The next thing done was to join the diagonal cut upward, until the opening was small enough to fit the duodenum to it. A complete separation of the tumor from the duodenum was effected next by an incision one centimetre on the other side of the infiltrated portion, and parallel to the cut through the stomach. Then the duodenum was introduced into the opening left in the stomach. About fifty stitches were taken with Czerny's carbolized silk. The whole was cleansed with a two per cent. carbolized solution. The stitches were then examined, and a few more added where there seemed to be weak spots. The whole was replaced in the abdominal cavity, the outer wound closed, and the bandages applied.

The operation lasted about one hour and a half. No weakness, no vomiting, and no pain seemed to be apparent after the operation. The patient was given ice only in the first twenty-four hours, then peptonized injections with wine; on the following day, at first every hour only, then every half-hour, a tablespoonful of sour milk. The woman slept the greater part of the night, with the aid of a small injection of morphine. The only food

taken for some days after the operation consisted of sour milk, one litre a day, as an attempt to nourish the patient with broth did not seem acceptable to her. The peptonized injections were dispensed with, as they produced flatulence and colic. Injections of wine three times daily were therefore substituted. The patient, upon her own request, was a few days later removed to the general ward, and she has since been discharged from the hospital, cured. The excised part measures at the greater curvature (*horribile dictu !*) fourteen centimetres, and it is with difficulty only that I am enabled to pass a goose-quill through the pylorus. The shape of the stomach is changed little by the operation. It is only a little smaller than formerly.

LITERARY NOTICES.

GENERAL PHYSIOLOGY OF MUSCLES AND NERVES. By Dr. J. ROSENTHAL, Professor of Physiology in the University of Erlangen. ("International Scientific Series," No. XXXII.) New York: D. Appleton & Co. 1881. Pp. 324. Price, $1.50.

PROFESSOR ROSENTHAL has well conformed to the theory of the "International Scientific Series" in the preparation of this work. It was designed to consist of monographs on special subjects, and not of complete scientific treatises. In this way particular subjects may be more fully expounded than they are in the text-books, while yet the form of publication is popular and convenient. If any one, for example, looks in the manuals of physiology for a statement of the relations of muscles and nerves, he will find that the information, if not scanty, is still most incomplete. Yet such are the interest and importance of the subject, that many would like to consult a more adequate presentation. Professor Rosenthal's volume will meet their requirements. It goes over the whole ground of the recent researches into muscular and nervous action, and is, moreover, the first attempt to deal with it in a popular and methodical way.

But few men could have been found as well prepared for the execution of his task as Professor Rosenthal. The problem of muscles and nerves has occupied his life. He worked for many years in connection with Professor Émile Du Bois-Reymond, the celebrated Berlin physiologist, to whom the present volume is dedicated. Broadly cultivated in the physiological field, and long disciplined in the experimental research of nervo-muscular relations, he has been enabled to give weight and authority to his exposition of the subject.

On general and obvious grounds, no subject is more important than this, and we can think of none that should more deeply interest all classes of readers. Man is a being endowed with great capacities of accomplishment by virtue of the agency of muscles and nerves. They are the means of his pleasures and the sources of his pains. One would think that he might be concerned to understand something about them; and, if he has any sense of the relative values of different kinds of knowledge, that he would place the understanding of his own mechanism first, and desire a thorough acquaintance with all that is positively known concerning the conditions of muscular and nervous exercise. The topic, besides, is one of profound intellectual interest. Nothing is more wonderful than the working of that higher organic mechanism by which power in the living being is exerted and controlled. There is nothing so subtile, so curious, so marvelous, as that incessant interaction of the muscular and nervous systems which is involved in all the familiar activities and operations of the human body. The strange thing is how it has been so finely and fully elucidated. Many things, of course, remain still mysterious and unsettled, but we have a large body of well-established facts and principles that have been most difficult of determination, and which forms one of the great monuments of skillful, persevering, and successful scientific labor. Physics and chemistry are generally spoken of as the experimental sciences, but physiology is also now in the highest sense an experimental science, while, for delicacy and difficulty of operation and consummate contrivances for dealing with obscure and complex phenomena, the physiological laboratory has precedence of all the workshops of experiment. Professor Rosenthal's book is filled with elegant illustrations of physiological instruments and apparatus, and there are many exquisite

diagrams to show the interactions of the nervous and muscular parts, as it is now proved that they take place.

We have here no space for the details of the book, but may refer to one of the most delicate and interesting of the machines employed, which is a device for the electric measurement of the muscle-pulsation. By its use the infinitesimal periods of time consumed in these pulsations are magnified and represented side by side in a wavy line, so that their durations can be compared and measured by a standard. The continued strain of a muscle is shown to be a chain of these tiny pulsations which decline steadily in strength as each pulsation exhausts a certain amount of material corresponding to the carbon removed from its place under the steam-boiler by combustion. The modern view that the power generated by muscle is due to the hydrocarbonaceous matter oxidized, instead of the nitrogeneous element of muscular structure, is clearly brought out.

It has long been a question in what way the nerves are mechanically or structurally related to the muscles, or what is the nature of the ultimate connection. Of course this was a microscopical problem upon which further light was constantly thrown as the instruments reached higher powers, and observers became more skilled in their use, and more experienced in guarding against errors. As was natural, different views were entertained by different able observers, and, as was equally natural, sharp controversies followed. How the case stands at present may be gathered from the following statement from Chapter XV: "If we trace the course of the nerve within the muscle, we find that the separate fibers, which enter the muscle in a connected bundle, separate, run among the muscle-fibers, and spread throughout the muscle. It then appears that the single nerve-fibers divide, and this explains the fact that each muscle-fiber is eventually provided with a nerve-fiber—long nerve-fibers even with two—although the number of nerve-fibers which enter the muscle is generally much less than the number of the muscle-fibers which compose the muscle. Till the nerve approaches the muscle-fiber, it retains its three characteristic marks—the neurilemma, medullary sheath, and axis-cylinder. When near the muscle-fiber the nerve suddenly becomes thinner, loses the medullary sheath, then again thickens, the neurilemma coalesces with the sarcolemma of the muscle-fiber, and the axis-cylinder passes directly into a structure which lies within the sarcolemma pouch, in immediate contact with the actual muscle-substance, and is called the *terminal nerve-plate*." There are some differences here in different classes of animals, but "the essential fact is the same in all cases: *the nerve passes into direct contact with the muscle-substance*. All observers are now agreed on this point. Uncertainty prevails only as to the further nature of the terminal plate."

THE OLD TESTAMENT IN THE JEWISH CHURCH: TWELVE LECTURES ON BIBLICAL CRITICISM. By W. ROBERTSON SMITH, M. A. New York: D. Appleton & Co. 1881.

PROBABLY no subject which interests so many people and interests them so deeply is so little studied or understood as the history of the Bible. In these three kingdoms there are every Sunday between fifty and sixty thousand clergymen of various religious bodies discoursing upon it, a very much larger number of persons teaching it in Sunday-schools and day-schools, an overwhelming majority of the population reading it, more or less, and looking to it as the guide of faith and practice. Yet not one man in a thousand, even in the educated classes, knows anything about the respective dates of the different books of the Bible, the mode in which they were preserved and received into the canon of Scripture, or the views entertained by scholars as to their authorship. This ignorance is deepest and most widespread as regards the Old Testament. Wonderful progress has been made during the last fifty years in the criticism of the numerous writings which make it up. It is not too much to say that we have gained more knowledge on the subject within that period than all the labors of all Biblical scholars succeeded in amassing during the two thousand years that preceded. Yet the bulk of the English cultivated public, which learned at college at least all that is known about the Servian Constitution and the Twelve Tables, which has a fair idea

of the issues of the great Homeric controversy, has no idea of the fresh light that has been thrown on the books which are read under the name of Moses, or the character and historical position of such men as Samuel, David, or Isaiah. Oriental scholars, a very small class in England, have been so much occupied in study as to have scarcely cared to give the results of recent inquiry to the general public. Lately some valuable translations of German treatises have begun to appear, but these have been too elaborate and bulky to attract ordinary readers. The appetite has continued to languish for want of the proper food.

It need now languish no longer. Professor Robertson Smith's book is exactly what was wanted at once to inform and to stimulate. Written by one of the first Semitic scholars of our time, it is completely abreast of the most recent investigations, and pervaded by a thoroughly scholar-like spirit. His easy mastery of the subject and his sense of which are the really difficult points and which the settled ones are apparent on every page. What is more surprising is the skill wherewith these resources are used. Although scientific in the sense of being thorough, exact, and business-like, the book is also popular—that is to say, it is perfectly intelligible to every person of fair general education who has read the Bible. For clearness of statement, for cogency of argument, for breadth of view, for impartiality of tone, for the judgment with which details are subordinated to the most interesting and instructive principles and facts, it is a model of how a great and difficult subject should be presented to the world. It is so condensed as to need close attention. But those who have any taste for these studies will not find it hard to give that close attention, for it carries one on like a romance from beginning to end, and we can well believe, what was stated in the newspapers some weeks ago, that the lectures, of which it is a summarized reprint, were listened to by immense audiences in Scotland with the keenest interest.

The book opens with a sketch of the criticism of the Old Testament in the Christian Church from the days of the earliest Fathers. It is shown how their entire want of Hebrew scholarship contributed, with their theories as to the nature and value of Scripture, to lead them away from a critical interpretation of the text; how even Jerome was obliged, when making his famous translation, to lean upon Jewish rabbis; how it was only among the Jews that the knowledge of the old language was preserved down till the Reformation, when such revivers of learning as Reuchlin drew their knowledge from Jewish sources; how thus the traditional interpretations and notions which were current among the Jews continued to influence Protestant scholars in their translations, and have colored our own authorized version. Then the author goes on to show how the Jewish traditional interpretation was itself formed. Old Hebrew became a dead language in or before the fourth century B. C., so that the Jews of our Lord's time, speaking Aramaic, needed special school-training to understand the Law, the Psalms, and the Prophets. As there were no grammars nor dictionaries, the knowledge of the old tongue was given orally, and a traditional mass of learning grew up, consisting of the interpretation of the sacred writings, with explanations and commentaries, partly legal (the so-called Halacha), partly moral or hortatory (the Haggada). The Law having now become the center of the whole life of the nation, as well civil as religious, and the guide of all its habits and usages, the function of those who interpreted and expounded and applied it became an extremely important one, and they rose, in the period between the return from Babylon and the birth of Christ, into a class of great power and influence. They are those whom we find mentioned in the New Testament as the Scribes, mostly belonging to and in fact heading the party called Pharisees. Their interest in the Law was primarily practical, and in their work of extending, supplementing, harmonizing, refining upon its rules they created a large body of customary law side by side with it, and were thus led to originate many forced and unreasonable interpretations, which have come down to us in the Talmud, and long continued to pervert the true meaning of the old writings. Though philology or grammatical exegesis was not in their way, nor indeed within their com-

petence, they were of course zealous for the preservation of a correct and uniform text, and it was apparently by them that the text which we now have was fixed. The date of this fixing becomes important, and may be proved by incidental evidence. Down to the apostolic age there seem to have been manuscripts of the various books of the Old Testament in circulation which varied considerably from one another; this appears by the divergences from our received text both of the Septuagint Greek translation made in the third century B. C., and of the Samaritan Pentateuch dating from the fifth century B. C., as well as by other evidence. But all our present MSS., none of which is older than the ninth century A. D., present what is practically one and the same text—showing that they must have been made from one archetypal MS. This text is the same text as Jerome used in making his Latin version in the fifth century A. D.; and it may be traced back with some certainty to the second century A. D. There is, therefore, good reason to believe that in the first Christian century one MS.—probably one of the three which we are told were then preserved in the Temple—was taken as authoritative, and all official copies ordered to be thenceforth made from it, every other MS., showing a different text, being discredited or even suppressed. From that time the text was guarded with the most scrupulous care, copies being made by a guild named the Massorets (possessors of tradition), who did not venture to change even an accidental peculiarity of writing. But, as many centuries had elapsed between the original writing of the books and the determination of this received text in the post-apostolic age, many variations had of course grown up. By far the most ample evidence of these variations is that supplied by the Septuagint; and one of the most interesting parts of Professor Smith's book consists in his account of the relation between the present Hebrew text and this old Greek translation, which carries us back to forms of the text that afterward perished. In common with the bulk of recent scholars, he sets a high value on many of the Septuagint readings, conceiving that they often give passages in a simpler and earlier form than that of the established Hebrew, which has been injured by the amplifications of editors, or, in some few cases, altered by copyists who did not fully understand the old language. These variations are more numerous and important in the Prophets than in the Law, because the latter held so important a place in the services of public worship, where it was read through once in three years, that the copying of it was performed more accurately and a uniform text better preserved. The author then goes on to show how little reliance can be placed on some of the titles prefixed to the canonical books, and how many traces we find of the action of a succession of editors or *rédacteurs* in getting the books into their present shape. Explanations were added; one document was joined on to another; in some cases it would seem that a book was written by taking an old series of annals or official records and filling into it anecdotes and descriptions from some other source. Next the formation of the Old Testament canon is discussed; and it is shown how, as in the case of the New Testament, different views as to the canonicity of particular books were from time to time prevalent among the Jews down till the second century A. D. The tales which ascribe the settlement of a canon to Ezra or to Nehemiah are shown to rest on no foundation. The inclusion of some of the Apocryphal books in the Septuagint shows that among the Alexandrian Jews these books enjoyed a certain authority, and yet they are not quoted—by Philo, for instance—as if they stood on the same level with the Prophets; for there was a feeling, a true feeling, that the prophetic voices had come to an end a few generations after the return from Babylon, or as Josephus too precisely puts it, in the time of Artaxerxes I. These books are all comparatively late, and to modern criticism stand on quite a different footing from the Prophets, whose authority seems to have become early established. But grave doubts were long entertained as to some of what we now consider canonical books. Daniel and Esther were disputed in the apostolic age, Ecclesiastes and the Song of Solomon not finally admitted till the time of Rabbi Akiba, who lived under Hadrian.

The second half of Professor Robertson Smith's book is devoted to an inquiry into

the relative date of the more important of the Old Testament books, and particularly of the Pentateuch. He examines the view, which has been traditional among Jews and Christians for two thousand years or so, that the books containing the Law of Moses are the oldest part of all the sacred writings, and belong to the time of Moses himself; pointing out that on this hypothesis we may reasonably expect to find many references to it in the historical and prophetic books, which would show that its ordinances were well known and were obeyed at least by the loyal worshipers of Jehovah, even if neglected by a large part of the nation during its frequent lapses into idolatrous worship. And he remarks with great truth that, considering not only the importance of ritual in early times, but the great prominence given to ceremonial in the Levitical system, the way in which "the feasts, the sacrificial ritual, the ordinances of ceremonial purity are always in the foreground, as the necessary forms in which alone the inner side of religion, love to God and man, can find acceptable expression," the observance of these forms and rites must have been a matter of the highest consequence, a matter in which the devotion of good kings and priests would appear, and on which the prophets would frequently insist in their exhortations to the people. The Law purporting to be, as we read it, a complete revelation of God's will for Israel's life, a rule of absolute validity, the keeping of which is the whole of Israel's religion, "the religious history of Israel can be nothing else than the history of Israel's obedience or disobedience to the law." Moreover, the position "that the whole legal system was revealed to Israel at the very beginning of its national existence, strictly limits our conception of the function and significance of subsequent revelation. The prophets had no power to abrogate any part of the law, to dispense with Mosaic ordinances, or institute new means of grace, other methods of approach to God in lieu of the hierarchical sacraments." The theory, the usual orthodox theory of modern times, that the prophets were "exponents of the spiritual elements of the law, who showed the people that its precepts were not mere forms, but veiled declarations of the spiritual truths of a future dispensation which was the true substance of the shadows of the old ritual, implies that the prophets were constantly intent on enforcing the observance of the ceremonial as well as the moral precepts of the Pentateuch. Neglect of the ritual law was all the more culpable when the spiritual meaning of its precepts was made plain."

To give this brief summary of Professor Robertson Smith's conclusions conveys a very imperfect idea of the admirable skill with which he applies his critical method. It sets familiar facts and expressions in a perfectly new light, illumining for us the whole religious and political history of Israel, and making that history more intelligible, more self-consistent, more instructive, than it had ever appeared upon the traditional view. — *Abridged from the Pall Mall Gazette.*

TRANCE AND TRANCOIDAL STATES IN THE LOWER ANIMALS. By GEORGE M. BEARD, A. M., M. D. New York. Pp. 17.

TRANCE is defined by Dr. Beard as "a concentration of nervous activity in some one direction, with corresponding suspension of nervous activity in other directions." It can be induced in all animals that have the rudiments of a nervous system, and is essentially the same in all, the differences that may be observed being in degree rather than in kind. The methods of inducing it are infinite, and no one of those that are best known can be said to have any special or preëminent virtue over any other, except of convenience and degree. Induced trance, by whatever way it is brought about, trance resulting from functional derangements, and spontaneous trance, are all parts of and obedient to the same law, and should be studied under that view. Hence special terms, like hypnotism, Braidism, somnambulism, catalepsy, etc., are misleading, and ought not to be used. Among the examples of trance in animals, Dr. Beard cites the various methods of subduing them by fear, lion-taming, the horse-taming operations of Rarey and Home, affecting them with music, all the phenomena that pass under the name of fascination, and stupefaction in the presence of fire.

JOURNAL OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA. Vol. VIII. Second Series. Part IV. Philadelphia: Printed for the Academy. Pp. 120, with Nine Plates.

THIS part of the Academy's "Journal" contains four papers, of which the first two, embodying descriptions of the Miocene and Pleiocene fossils of the Caribbean area and Costa Rica, were written by the late William M. Gabb while in San Domingo, during the winter of 1877–'78, and have been published since his death. The third paper is on "The Terrestrial Mollusca inhabiting the Cook's or Harvey Islands," by Andrew Garrett. The next paper, on "The Placenta and Generative Apparatus of the Elephant," by Henry C. Chapman, M. D., is based on observations of a female elephant attached to a menagerie, that gave birth to a young one in Philadelphia in 1880, and establishes the interesting fact that the period of gestation of the elephant is from six hundred and thirty to six hundred and fifty-six days. The other papers are by Joseph Leidy, M. D., and are on "The Parasites of the Termites," and on the *Bathygnatus borealis*, a fossil saurian from Prince Edward Island.

SECOND REPORT OF THE UNITED STATES ENTOMOLOGICAL COMMISSION FOR THE YEARS 1878 AND 1879, RELATING TO THE ROCKY MOUNTAIN LOCUST AND THE WESTERN CRICKET. With Maps and Illustrations. Washington: Government Printing-Office. Pp. 322; and Appendices, pp. 80.

THE present report embodies the conclusions that have been reached after careful examinations of the breeding-ground of the insects, of the regions in which they are permanently propagated, and of the "temporary region" where they may breed for a few years and then die out, with other knowledge that has been gained concerning their habits, and the best means of contending against them. The Commission claims that its prediction, that the series of invasions by the locust of the cultivated regions that began in 1874 would close in 1877, has been completely confirmed, and that its theory that the pest could not remain permanently in this region has been conclusively proved; consequently, the insect no longer excites the terror which its first appearances evoked. The locust is bred in the prairie tracts of the rainless district, in the loose, warm, gravelly soil, in the comparatively open spots, rather than in the thick grass, in different parts of a "permanent region," the area of which is not less than five hundred thousand square miles. The best single means of exterminating the broods would be to burn the grass while they are in the larva state; but this can not be relied on alone, because of the great extent of uninhabited country to which it would have to be applied, and because it can not be made thorough, since the burning would be lightest in the spots where the insects are thickest. The object must be promoted by other means, of which the first is to induce the settlement of the breeding district by farmers, who will fight the locusts in their homes; next, by the encouragement of irrigation, to bring unfriendly water to bear upon them, and of the planting of forests, in which they do not flourish; and by instituting a system of Signal-Service warnings of the progress of their migrations. The discussion of these points forms one of the most important chapters of the report; and this chapter, with the eight maps showing the vegetation of the regions the insects infest, has been also published separately. In addition to these topics, information is given concerning the migrations and ravages of locusts in other countries, their natural history and structure, and their natural enemies.

COÖPERATION AS A BUSINESS. By CHARLES BARNARD. New York: G. P. Putnam's Sons. Pp. 234. Price, $1.

MR. BARNARD devotes a chapter to the description of each of the principal forms in which coöperation has been practiced with success. In the first chapter the workings of the Philadelphia building associations are explained in full; accounts are given of the English systems nearest like theirs; the English and American systems are compared; and coöperative banks are explained. The second chapter is devoted to the coöperative stores that have been established in Great Britain for the benefit of consumers; the third to those which are conducted in the interest of producers, of which the establishment of the Paisley shawl-weavers is taken as the type. In the suc-

ceeding chapters are described the civil-service and similar stores, the coöperative insurance societies, the provident dispensaries, and the people's banks. The scope of the work is not, however, limited to the consideration of schemes of coöperation that have succeeded. Attention is also given to those that have failed, particularly in the United States, and the attempt has been made to examine and analyze the causes that have conduced to failure.

CONTRIBUTIONS TO THE ANATOMY OF THE MILK-WEED BUTTERFLY, DANAIS ARCHIPPUS (*Fabr.*). By EDWARD BURGESS, Secretary of the Boston Society of Natural History. Boston: Published by the Society. Pp. 16, with Two Plates.

THIS monograph is intended to serve as a guide to the general study of the structure of the *Lepidoptera*. The particular species is chosen as a type of the order well adapted to the purpose, on account of its large size, common occurrence, and wide distribution, and partly because the anatomy of no species of *Danaidæ* has yet been studied.

LOCKE'S CONDUCT OF THE UNDERSTANDING. Edited, with Introduction, Notes, etc., by THOMAS FOWLER, M. A. Oxford: The Clarendon Press. Pp. 136. Price, 50 cents.

ALTHOUGH this fragment is not finished, but was written and left only as a rough draught of a chapter which the author intended to complete and add to its essay, it has been regarded, even in its crude shape, as one of the most valuable aids to self-culture. Professor Fowler has endeavored to make it more generally useful by means of added notes and suggestions, without changing the text.

MIDDLETOWN SCIENTIFIC ASSOCIATION. Occasional Papers. No. 1. ANNUAL ADDRESS OF THE PRESIDENT, Rev. FREDERICK GARDNER, D. D., January 18, 1881. Middletown, Connecticut. Pp. 19.

THE address marks the completion of the tenth year of the Association, the meetings of which have been kept up all the time with reasonable regularity. The President discusses the special subject of "The Universality of the Laws of Heredity and Variability."

RAILROADS AND TELEGRAPHS: WHO SHALL CONTROL THEM? By F. H. GIDDINGS. Springfield, Massachusetts: "The Manufacturer and Industrial Gazette." Pp. 12.

THE author recognizes the wickedness of monopolies and the abuses they engender, but holds that the remedy is not to be found in State possession or control of railroads and telegraphs. Any close regulation or supervision by the State would aggravate the evils and increase the number and power of rings. The people who use the lines should take the control into their own hands by becoming stockholders and attending to the management of them.

THE DIET-CURE; THE RELATIONS OF FOOD AND DRINK TO HEALTH, DISEASE, AND CURE. By T. L. NICHOLS, M. D. New York: M. L. Holbrook & Co. Pp. 83. Price, 50 cents.

THIS book teaches that pure food makes pure blood, and pure blood builds up a healthy body. The author believes that it is needed, notwithstanding all that has been written on the subject, because "there are still people who eat and drink more than is good for them, as well as what is bad for them."

MODERN ARCHITECTURAL DETAILS: For Dwellings and Cottages in Modern Styles. New York: Bicknell & Comstock. To be completed in Ten Parts, each containing Eight Plates. Price, $1 for each part.

THE purpose of this work is to present new and original designs of dwellings at moderate cost, in the Queen Anne, Eastlake, Elizabethan, and other modernized styles, exterior and interior details of houses, stores, offices, etc., and designs of low-priced cottages. The drawings are furnished by a considerable number of contributors, so that variety is assured. The sixth number contains perspectives of two dwellings, with the details carefully wrought out.

THE MAGAZINE OF ART, April, 1881. London, Paris, and New York: Cassell, Petter, Galpin & Co. Pp. 48. Price, 35 cents.

THIS number contains, besides special papers, articles on "Symbolism in Art," "Architectural Sculpture," and the "Ideal in Ancient Painting."

How to tell the Parts of Speech; an Introduction to English Grammar. By the Rev. Edwin A. Abbott, D.D. American edition, revised and enlarged, by John G. L. McElroy, A. M. Boston: Roberts Brothers. Pp. 143. Price, 75 cents.

Dr. Abbott is also the author of other works on the construction of the English language, which, with this, have the common characteristics that, in them, the artificial rubbish that overloads nearly all English grammars is rejected, and the endeavor is made to place the study of the language on a basis of common-sense. They are prepared under the conviction that it is the business of a teacher to teach the boy not how to speak, but how to understand, English, and how to see the reasons for the anomalies in the language; that the pupil should first learn to perceive the function of the word, and thence deduce its grammatical quality, rather than to give first the grammatical definition, and afterward seek the reason for it.

A Fourth State of Matter. By Alexander E. Outerbridge, Jr. Philadelphia. Pp. 11.

This is the substance of a lecture which was delivered before the Franklin Institute, February 17th last, when some of the experiments of Professor Crookes were repeated and his theory was explained with familiar illustrations and a reference to the "vortex atom theory" of Sir William Thomson.

Report of the Director of the Detroit Observatory of the University of Michigan to the Board of Regents. For the Period beginning October 1, 1879, and ending January 1, 1881. Ann Arbor, Michigan: Published by the Regents. Pp. 20.

In the astronomical department of the observatory two comets were discovered, one of which was new; the other had been seen the evening before at Strasburg. The meteorological observations were directed to the study of the climate of Ann Arbor, the daily fluctuations of the meteorological elements, and the character of local storms. As collated and summarized in the report, and compared with the general observations of the Signal Service, they furnish facts of much value.

Report of the Superintendent of the United States Coast and Geodetic Survey. Appendix No. 10, Meteorological Researches. By William Ferrel. Part II. On Cyclones, Tornadoes, and Water-Spouts. Washington: Government Printing-Office. Pp. 95, with Six Plates.

The theory of cyclones is wrought out in the first chapter with great care and elaboration. In the second chapter, the practical applications of the theory, as its operation is modified by the encounter with actualities, are discussed, and the theoretic results are compared with those of observation. The third chapter is devoted to the phenomena of tornadoes, hail-storms, and water-spouts.

Our Trees in Winter. By John Robinson. From the Bulletin of the Essex Institute. Vol. XII. Pp. 16.

This is the substance of a paper which was read at the first winter field meeting of the Essex Institute, at Chebacco Pond, held in January last. It discusses the faculty which many trees possess of adapting themselves to different climates; the manner in which trees escape injury from freezing through the withdrawal of water from their tissues in winter; and the opportunities which winter affords for the study of trees, which are better for many purposes than those given by summer.

Report of the Cruise of the United States Revenue Steamer Corwin in the Arctic Ocean. By Captain C. L. Hooper, U. S. R. M. Washington: Government Printing-Office. Pp. 73, with Five Charts.

The Corwin left Oonalaska June 8, 1880, and proceeded by way of Nunivak Island, St. Lawrence Island, Kotzebue Sound, the "ice-deposits" of Elephant Point, and the coal-veins of Cape Lisburn, to Point Barrow, and thence to Herald Island and within twenty-five miles of Cape Wrangel, whence it returned. During the cruise, observations were taken on the lands and the people, the illicit trade of the coast was looked after, and the Jeannette was inquired for. The report contains fresh and valuable anthropological notes, observations on natural history, and "the ice and its habits," and views of prominent points.

INDUSTRIAL CONCILIATION AND ARBITRATION IN NEW YORK, OHIO, AND PENNSYLVANIA. By JOSEPH D. WEEKS, A. M. From the Twelfth Annual Report of the Massachusetts Bureau of Statistics of Labor. With Comments by CARROLL D. WRIGHT, Chief. Boston. Pp. 75.

MR. WEEKS has furnished in this paper a large amount of information from the experience of business establishments in his own and other States. Conciliation is the arrival at a mutual understanding, in case of difficulties between employers and employed, either through their own discussions or the intervention of friendly parties, and is voluntary. It was first brought into effect in the iron-works at Pittsburg, in 1866, and has been continued, with only such interruptions as were provided for in the agreements and were consistent with their terms, till the present time. Thence it has been extended to establishments in West Virginia and Ohio. Arbitration is reference of the dispute to an umpire, whose decision is intended to be binding. It has been tried in the anthracite, Pittsburg, and Shenango coal-regions in Pennsylvania, and in the coal-mines of Ohio, and has always so far failed. One instance of its successful operation in this country is in a large cigar-manufactory in this city, where the relations between the proprietors and their workmen appear to be established on the most agreeable basis. The full history of all these efforts is given in the pamphlet.

OBSERVATIONS ON JUPITER. Presented to the American Academy of Arts and Sciences, March 9, 1881. By L. TROUVELOT. Pp. 22.

M. TROUVELOT began in 1876 a series of observations on the planets, for the purpose of studying them at every point of their orbits. Five hundred and ninety-one observations were made on Jupiter during five years, and not quite as many drawings were taken. The planet showed signs of lively commotion in 1876, when a spot was recognized on a second observation only once. During the following years the planet was more quiet, the spots were more durable, and one, the "great red spot," was persistent for several months. The periods of rotation of the planet, as deduced from observations of the spots, exhibit variations which appear to be dependent upon their proper motion. The great spot gives a period of between 9h. 55m. 38·81s. and 9h. 55m. 43·96s. M. Trouvelot thinks this is as near to the actual period as we are ever likely to arrive.

WORKING DRAWINGS, AND HOW TO USE THEM. By LEWIS M. HAUPT, Professor of Civil Engineering in the University of Pennsylvania. Philadelphia: Joseph M. Stoddard & Co. Pp. 55, with Nine Charts of Figures.

BY the usual teaching of drawing, pupils learn to observe and copy from models, and to construct perspectives "by rule-of-thumb," but not, the author believes, except in the case of patterns for tapestry, carvings, and similar applications, to invent designs from which constructions can be made. For this purpose the designer should be able, in order that the object he conceives may be constructed from the drawing, to dissect it and so to project its several parts on the plane of the paper, that the artisan shall know just where to find them, and what they represent. The present work is designed as an introduction to this branch of the study.

IMAGINARY QUANTITIES: Their Geometrical Interpretation. Translated from the French of M. R. Argand. By Professor A. S. HARDY. New York: D. Van Nostrand. Pp. 135. Price, 50 cents.

M. ARGAND was the first who undertook (in 1806) to suggest the true theory of the so-called imaginary quantities of mathematics. He was followed, twenty-five years afterward, by Gauss, and later by other authors who have given the subject a fuller development. The translation of his essay is followed in the present volume by notes on the geometrical interpretation of imaginary quantities by Professor Hardy.

THE ENDOWMENT OF SCIENTIFIC RESEARCH. From the Annual Address of the President of the California Academy of Sciences, Professor GEORGE DAVIDSON, A. M., Ph. D. Pp. 8.

THIS is a strong presentation of the proofs that science is economically profitable, and of the arguments in favor of its endowment with means to prosecute investigations.

ABSTRACT OF TRANSACTIONS OF THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON, D. C., with the Annual Address of the President, for the First Year, ending January, 1880, and for the Second Year, ending January 18, 1881. Prepared by J. W. POWELL. Washington. Pp. 150.

THE President's address reviews the work of the Society during two years, and describes generally the papers that were read, according to the particular department of anthropological science to which they severally relate. The papers for the most part concern American subjects, and are founded on original observations. The summaries contain much that endows the subject with interest and is adapted to stimulate continued investigations.

THOUGHTS ON AGRICULTURAL EDUCATION. By E. LEWIS STURTEVANT, M. D., South Framingham, Massachusetts. Pp. 19.

DR. STURTEVANT explains in an address the purpose and scheme of an agricultural college. In the discussion following the address, a minute of which is published with it, the teaching of agriculture in the common schools and the relative importance to farmers of instruction in advanced arithmetic and agricultural chemistry are considered.

THE NATURE OF VIBRATION IN EXTENDED MEDIA AND THE POLARIZATION OF SOUND. By S. W. ROBINSON, Professor of Physics and Mathematics, Ohio State University.

THIS is mainly an argument, based upon experiments made by the author in effecting the polarization of sound, to show that the phenomena of polarization of light, heretofore supposed to be due to transversal vibrations, can be explained on the basis of longitudinal vibrations alone. This done, no reason is left for assuming that the waves of light differ in character from other waves which are the result of longitudinal vibrations. The experiments and their results are described in detail.

HISTORY OF THE CHRISTIAN RELIGION TO THE YEAR 200. By CHARLES B. WAITE, A. M. Chicago: C. V. Waite & Co. Pp. 455. Price, $2.50.

THIS work is the result of years of laborious study, in which the author professes to have consulted all the writings of the first two centuries, and the works of the fathers of the Church, "in the interest of no church, creed, or dogma," but for his own satisfaction. In it he discusses the origin and history of all the gospels, those which are called apocryphal, forty in number, as well as those which have become canonical, and has compared three of the most famous of the apocryphal gospels in parallel passages with the canonical records. He adds sketches of nearly a hundred Christian writers of the first two centuries, with notices of their works, and a history of Christian doctrine for the same period, and declares his conclusions as to what is genuine.

A PRACTICAL TREATISE ON NERVOUS EXHAUSTION (NEUROSTHENIA); ITS SYMPTOMS, NATURE, SEQUENCES, TREATMENT. By GEORGE M. BEARD, M. D. Second and revised edition. New York: William Wood & Co. 1880. Pp. 198. Price, $1.75.

NERVOUS exhaustion, according to Dr. Beard, is more common in this country than any other form of nervous disease, and, with other forms toward which it tends, constitutes a family of functional disorders that are of comparatively recent development, and that especially abound in the northern and eastern part of the United States. The author gives, in this volume, the result of the study and experience of his entire professional life on the subject. He describes the symptoms of the disease, showing their relations and interdependence, distinguishing them from the often closely resembling symptoms of other diseases, and discusses the complex developments and manifestations of the malady, its pathology, treatment, and hygiene. The consideration of the causes of the disorder is left for another volume.

PUBLICATIONS RECEIVED.

On Philadelphite. By Henry Carvill Lewis. Reprinted from the "Proceedings of the Academy of Natural Sciences," of Philadelphia. 1879. Pp. 16.

Extinct Cats of North America. 1880. Pp. 25. Some New Batrachia and Reptilia from the Permian Beds of Texas, etc. 1881. Pp. 45. The Systematic Arrangement of the Order Perissodactyla. 1881. Pp. 36. Second Contribution to the History of the Vertebrata of the Permian Formation of Texas. 1881. Figures. By Professor E. D. Cope.

The Bolometer. By Professor S. P. Langley.

Read before and published by the American Metrological Society. New York. 1881. Pp. 7. Illustrated.

Geological Survey of Alabama. By Eugene A. Smith, Ph. D. Montgomery, Alabama. 1881. Pp. 158, with Maps.

Politico-Social Functions. By Lester F. Ward. Reprint from "Penn Monthly." 1881. Pp. 16.

A Collector's Notes on the Breeding of a Few Western Birds. By J. Holterhoff. 1881. Pp. 12.

The Climate, Soils, Timber, etc., of Kentucky contrasted with those of the Northeast. By John R. Proctor. Frankfort, Kentucky. 1881. Pp. 29.

Notes on North American Microgasters. By C. V. Riley, Ph. D. From the "Transactions of the St. Louis Academy of Sciences." 1881. Pp. 20.

Ninth Annual Report of the Board of Directors of the Zoölogical Society of Philadelphia. 1881. Pp. 32.

Mya Arenaria in San Francisco Bay. By Robert E. C. Stearns. Reprint from "The American Naturalist." 1881. Pp. 5.

The Landa Alphabet. A Spanish Fabrication. 1880. Pp. 35. Mexican Paper, an Article of Tribute. Its Manufacture, Varieties, and Uses. 1881. Pp. 26. By Philipp J. J. Valentini, Ph. D. Worcester, Massachusetts.

Inductive Metrology. By W. J. McGee. Reprint from "The American Antiquarian." 1881. Pp. 8.

Nostrums in their Relation to the Public Health. By Albert B. Prescott, M. D., F. C. S. Reprint from "The Physician and Surgeon," Ann Arbor, Michigan. 1881. Pp. 12.

Principal Characters of American Jurassic Dinosaurs. By Professor O. C. Marsh. Part V, with Seven Plates. Reprint from the "American Journal of Science." 1881. Pp. 7.

Antiquities of New Mexico and Arizona. By W. J. Hoffman, M. D. Davenport Academy of Natural Sciences. 1881. Pp. 18. Four Plates.

Gill Nets in the Cod-Fishery, etc. By Captain J. W. Collins. Bulletin U. S. Fish Commissioner. 1881. Pp. 17. Twelve Plates.

The Total Solar Eclipse of July 29, 1878. Observations at Pike's Peak, Colorado. Report of Professor S. P. Langley. Pp. 14, with Plate.

Anthropology: an Introduction to the Study of Man and Civilization. By Edward B. Tylor, D. C. L., F. R. S. With Illustrations. New York: D. Appleton & Co. Pp. 448.

English Philosophers. David Hartley and James Mill. By G. S. Bower, M. A. New York: G. P. Putnam's Sons. Pp. 250. $1.25.

Osteology of Speotyto Cunicularia, Var. Hypogæa, and of Eremophila Alpestris. By E. W. Shufeldt, First-Lieutenant and Assistant Surgeon, U. S. Navy. Washington, D. C. Pp. 60, with Four Plates.

Literary Style, and other Essays. By William Mathews, LL. D., author of "Getting on in the World," etc. Chicago: S. C. Griggs & Co. Pp. 345. $1.50.

Text-Book of Experimental Organic Chemistry for Students. By H. Chapman Jones. New York: D. Van Nostrand. Pp. 145.

The Wilderness-Cure. By Marc Cook, author of "Camp Lon." New York: William Wood & Co. Pp. 153.

The Figure of the Earth. An Introduction to Geodesy. By Mansfield Merriman, Professor of Civil Engineering in Lehigh University. New York: John Wiley & Sons. Pp. 88. $1.50.

Induction Coils: how made and how used. New York: D. Van Nostrand. Pp. 123. 50 cents.

How a Person threatened or afflicted with Bright's Disease ought to live. By Joseph F. Edwards, M. D. Philadelphia: Presley Blakiston. Pp. 87. 75 cents.

The Library. By Andrew Lang. With a Chapter on Modern English Books, by Austin Dobson. London: Macmillan & Co. Pp. 184. $1.25.

Anniversary Memoirs of the Boston Society of Natural History, 1830–1880. Boston: Published by the Society 1880.

Kant and his English Critics. By John Watson, M. A., LL. D. New York: Macmillan & Co. 1881. Pp. 402. $4.00.

A Memorial of Joseph Henry. Published by Order of Congress. Washington: Government Printing-Office. 1880. Pp. 525.

Life of Voltaire. By James Parton. Boston: Houghton, Mifflin & Co. 1881. 2 vols. Pp. 639 and 653. Per vol., $3.

Demosthenes: with Extracts from his Orations, and a Critical Discussion of the Trial on the Crown. By L. Brédif. Translated by M. J. Macmahon, A. M. Chicago: S. C. Griggs & Co. 1881. Pp. 510. $3.

Illustrations of the Earth's Surface-Glaciers. By Nathaniel Southgate Shaler and William Morris Davis. Boston: James R. Osgood & Co. 1881. Folio, pp. 196. Twenty-five Plates, with descriptions. $10.

POPULAR MISCELLANY.

Meeting of the American Association.—The thirtieth meeting of the American Association for the Advancement of Science will be held in Cincinnati, Ohio, beginning August 17th. A large and efficient local committee is making all possible arrangements for the success of the meeting, in order that it may be the largest and most important scientific meeting ever held in the West. Professor G. J. Brush, of New Haven, Connecticut, is President for the year, with Professor A. M. Mayer, of Hoboken, New Jersey, as Vice-President of Section A. The vice-presidency of Section B is vacant, in consequence of the resignation of Dr. Engelmann, who is in Europe. The chairmen of the sub-sections are: of Chemistry, W. R. Nichols, of Boston; of Microscopy, A. B. Hervey, of Taunton, Massachusetts; of Anthropology, Garrick Mallory, of Washington, D. C.; of Entomology, John G. Morris, of Baltimore, Maryland. The changes in the constitution of the Association which were proposed at the Boston meeting will be considered at this meeting. They are intended to enlarge the scope of the Association, and effect a reorganization of the sections, as follows: Section A, Physics; B, Astronomy and Pure Mathematics; C, Chemistry and its applications; D, Mechani-

cal Science; E, Geology and Geography; F, Biology; G, Anthropology; H, Economic Science and Statistics; I, a permanent subsection of Microscopy. The contemplated excursions include one by the Anthropological Section to "Fort Ancient." A loan exhibition of scientific apparatus, appliances, and collections, will be held, in connection with the meeting, by the department of Science and Arts of the Ohio Mechanics' Institute.

The French Association at Algiers.—The French Association for the Advancement of Science met at Algiers, April 14th, and was attended by about fifteen hundred persons, among whom a large proportion of medical men was observed. The opening address was by the President, M. Chauveau, Professor of Physiology in the Lyons Veterinary College, and related principally to the germ theory and Pasteur's theory of fermentation. Several papers on local subjects, chiefly relating to the geology, geography, and demography of Algeria, were read in the general Association, among the results of the presentation of which were the diffusion of much information concerning the colony, and the acquisition of matter which will tend to help its development. One of the most interesting of these papers was by Colonel Playfair, the British consul-general, one of the only two Europeans who have visited their country, on the Kroumirs. Among the papers read in the sections, those in the medical and agronomical sections predominated over all the others. Most of the papers in the mathematical section related to subjects of pure geometry, and several of them were by foreign mathematicians. M. Trepied brought forward a project for the construction of an observatory at Algiers. The most important papers in the section of civil engineering were by Colonel Fourchault, on defensive villages, and by M. Trémaux, on irrigation. Accounts of the lead and iron mines of Tunis, and the copper-mines of the Petit Kabylie, were given in the geological section. Meteorology was well cared for with papers on the meteorology of Asia and of the Sahara, on meteorological instruments, and other related subjects. Among the anthropological papers, which were numerous, were those on the Kabyles, the Tziganes, the Romans in Africa, the Berber migration, the civil, political, and religious institutions of the Jews, and some craniological studies; a prehistoric map of the north of Africa was discussed in this section. The most interesting medical papers were on the epidemics of Algiers, acclimatization, and on the climate of Algiers as regards its influence on consumptive patients. A considerable proportion of the agronomical papers also bore on Algerian interests. Botany, zoölogy, and zoötechny were inadequately represented. The new section of pedagogy was established under the presidency of M. Godard, of the École Monge, in Paris. The working sessions of the Association were shortened in order to give time for the entertainments, some of which were peculiar to the country, and the excursions—to the borders of Tunis, to the country of the Kabyles, to the Sahara, to the boundaries of Morocco, and to interesting spots in the province. Each member of the meeting was presented with a work of scientific, historical, and economical notices of Algiers and Africa; and, whatever else the conference may have done, it has helped to add immensely to the world's knowledge of Northern Africa.

The association has now had a successful career of ten years, and has done some good work. The topics of which it takes cognizance are divided into the four groups of mathematical, physical and chemical, natural and economic sciences, and are considered in sixteen sections.

Hereditary Color-Blindness.—A correspondent has furnished us an account of some remarkable instances of hereditary color-blindness. "I recently heard," she writes, "a very intelligent boy of fourteen speak in this manner: 'Father, you know that green or brown mare of Abe's?' The same lad, speaking of a colored person—'What color?' interrupted a captious listener. 'About that color,' answered the boy, pointing to a jar of pickled cucumbers. The lad, whom I call D——, belongs to a family who have for several generations been troubled with color-blindness. His grandfather was unable to distinguish red, green, and brown, and confounded blue and pink, but always named yellow aright." The

same ancestor was once surprised by hearing some one speak of his father's sleigh as being green on the outside and red on the inside, for it had always appeared to him to be of the same color on both sides. He was also heard to remark that he could see no change in the color of the maple-leaves, which, as we all know, turn from their summer green to red, and then to brown. This form of color-blindness is particularly inconvenient to persons who wish to pick cherries or strawberries, for they have only the forms to guide them, without any help from the color. One of the brothers of the grandfather and two of his first-cousins had the same defect, and a nephew in the next generation. The youth spoken of in the beginning of this notice is the first in the present generation who has manifested it. Generally the affection appears to have been transmitted through the female line of the family, but to sons, and not to daughters. Exceptions to this rule are noticed in the case of a great-uncle of the youth's mother, who inherited it from his father and transmitted it to his four sons; and of a female relative, through whom it was transmitted to two daughters. By means of the instances related, the course of the affection is traced through five generations.

Why Prairies are Treeless.—Mr. Thomas Meehan believes that we have nearly reached the solution of the question of the cause of the absence of trees from the prairies. It is not climatic, for timber-belts flourish in all the prairie regions. It is not in conditions of soil, for the prairie soil is the most favorable to the germination of seeds, of trees as well as of other plants, and artificial plantations are remarkably successful wherever they are made. The real cause is probably to be found in the annual fires which have swept over the prairies from time immemorial, killing the young trees before they can grow large enough to resist the heat. The seeds of the annual plants of the prairie vegetation, maturing every year, are shed and find protection before the fires come; the young trees, on the other hand, bear no seed, and can leave no resource for a succession after they are burned. This theory is supported by the fact that an abundant growth of trees has set in wherever the fires have been stopped. The fires were made by the aborigines for centuries before the white men came, possibly for the express purpose, Mr. Meehan suggests, of preventing the growth of trees and preserving the buffalo-pastures. The question remains how the prairies first came to be naked. They probably formed the bottoms of the lakes and marshes that were left after the retreat of the glaciers, and continued wet after the highlands were covered with trees. Man followed the glaciers so closely that he anticipated the trees on these spots, and, having learned already in southern latitudes the value of burnings, began them before the trees gained a foothold.

Darwin's Views on Vivisection.—The following is Mr. Darwin's reply to a letter from Professor Holmgren, of Upsala, requesting his views on the right to make experiments on living animals in the interest of science:

DOWN, BECKENHAM, *April* 14, 1881.

DEAR SIR: In answer to your courteous letter of April 7th, I have no objection to express my opinion with respect to the right of experimenting on living animals. I use this latter expression as more correct and comprehensive than that of vivisection. You are at liberty to make any use of this letter which you may think fit, but if published I should wish the whole to appear. I have all my life been a strong advocate for humanity to animals, and have done what I could in my writings to enforce this duty. Several years ago, when the agitation against physiologists commenced in England, it was asserted that inhumanity was here practiced, and useless suffering caused to animals; and I was led to think that it might be advisable to have an act of Parliament on the subject. I then took an active part in trying to get a bill passed, such as would have removed all just cause of complaint, and at the same time have left physiologists free to pursue their researches —a bill very different from the act which has since been passed. It is right to add that the investigation of the matter by a Royal Commission proved that the accusations made against our English physiologists were false. From all that I have heard, however, I fear that in some parts of Europe little regard is paid to the sufferings of animals, and if this be the case I should be glad to hear of legislation against inhumanity in any such country. On the other hand, I know that physiology can not possibly progress except by means of experiments on living animals, and I feel the deepest conviction that he who retards the progress of physiology commits a crime against mankind. Any one

who remembers, as I can, the state of this science half a century ago, must admit that it has made immense progress, and it is now progressing at an ever-increasing rate.

What improvements in medical practice may be directly attributed to physiological research is a question which can be properly discussed only by those physiologists and medical practitioners who have studied the history of their subjects; but, as far as I can learn, the benefits are already great. However this may be, no one, unless he is grossly ignorant of what science has done for mankind, can entertain any doubt of the incalculable benefits which will hereafter be derived from physiology, not only by man, but by the lower animals. Look, for instance, at Pasteur's results in modifying the germs of the most malignant diseases, from which, as it so happens, animals will in the first place receive more relief than man. Let it be remembered how many lives and what a fearful amount of suffering have been saved by the knowledge gained of parasitic worms through the experiments of Virchow and others on living animals. In the future every one will be astonished at the ingratitude shown, at least in England, to these benefactors of mankind. As for myself, permit me to assure you that I honor, and shall always honor, every one who advances the noble science of physiology.

Dear sir, yours faithfully,

CHARLES DARWIN.

To Professor HOLMGREN.

Tin in Australia and other Countries.—A German pamphlet by Dr. Eduard Reyer, on "Tin in Australia and Tasmania" (Vienna, 1880), gives some interesting facts relative to the production of tin in different countries outside of Europe. The mining of this metal has become an industry of considerable importance in the Australian colonies. The amount exported from Victoria to England rose from an average of about 130 tons a year between 1860 and 1869, to 2,500 tons in 1877; the production in New South Wales increased from 50 tons in 1872 to 7,000 tons in 1877. Four thousand tons were produced in Queensland in 1874; and the whole amount exported from Australia to England in the first five months of 1877, 1878, and 1879, was respectively 4,300, 4,100, and 2,900 tons. About 4,500 tons were produced in Tasmania in 1877; 4,100 were exported in the first five months of 1878, and 3,300 tons in the corresponding period of 1879. The ore occurs in Australia on the flanks of the mountains which run parallel to the eastern coast, in granite of the Devonian age, and has so far been got by washing from the sediment in the valleys. In Tasmania it is found in the quartz-porphyry of Mount Bischoff, and is likewise obtained by washing. Tin is found in several of the south-western provinces of China, but it is not so largely produced in that country that considerable quantities are not imported from abroad; it was formerly sent from Java to England; it was extensively mined in the province of Khorassan in Persia; is mentioned as having been formerly produced in Algeria; and is now produced in the Cape Colony at a rate represented by an exportation of about one hundred tons a year. It is found in small quantities or traces in several places in the United States, as in Maine, New Hampshire, Connecticut, Pennsylvania, Virginia, North Carolina, Missouri, and California, and in parts of Mexico, but the whole production of North America is hardly worth speaking of. It is, however, a definite article of production and export in some South American states, as Peru, Chili, and Bolivia; it exists in the province of Minas Geraes in Brazil; and several abandoned tin-mines are mentioned in the Spanish West Indies.

The Glacial Ice-Sheet in the Interior States.—Professor N. H. Winchell suggests, in the "American Journal of Science," that the peculiar formation of ice, which Mr. Dall has described as occurring near Behring Strait (see "Popular Science Monthly" for May, page 130), presents features which may formerly have prevailed in our Western and Northwestern States. Both regions are alike free from high land and rocky hills suited for the production of a glacier. The proof that vast fields of glacier-ice formerly existed over our Northern interior States is now rarely questioned; "and it is highly probable," says Professor Winchell, "that the field explored by Mr. Dall is an epitome, under peculiar and somewhat inexplicable circumstances, of the vaster fields which extended from the Rocky Mountains on the West to the Alleghanies on the East, during the latest epoch of continental ice, the only important exception being that over the continent the southern termination of the ice-sheet was everywhere invisible, and abutted nowhere (in the interior) on the

ocean-shore, so as to reveal its existence. The surface covering of the ice was the surface of the country, and, over many miles north from its actual termination, it supported a varied and even rank vegetation." Professor Winchell observes that the facts reported by Mr. Dall throw light on the manner of formation and deposit of the till, and on the origin of *kames*. The kames are gravel-ridges lying in till-covered countries, occupying the lower situations and generally bordered on either side by a parallel strip of swamp or low land. Now, if we suppose that the till before its deposit lay on the surface of the ice, it is plain that the surface drainage, gathering into streams, would produce deep channels in the ice-sheet, in the bottom of which would be gathered such stones and gravels as the stream could not carry away, and these would gradually sink deeper into the ice, perhaps to the rocky floor itself. When the ice had entirely disappeared, the bed of coarser matters thus formed "would lie undisturbed in its beautiful stratification, where the river produced it"; while on either side would be first the swampy or low land produced by the wash of the stream, and outside of this the unmodified till.

Undergrowth and Forest-Trees.—M. Gourmand has recently described some observations which he has made on the influence of thickets upon the decomposition of vegetable matter and the growth of large trees. A thicket may be formed in the course of eight or ten years after the undergrowth has started; as it rises in height we can at last distinguish between the atmosphere beneath it and the superior atmosphere to which the tops of the larger trees are exposed. Seventeen years of watching and periodical measuring of the growth of the trees of a tract bearing a deciduous undergrowth and a larger coniferous growth have shown that the rate of growth of the larger trees diminishes as the undergrowth becomes more dense; the only exceptions are in glades where the undergrowth sends up vertical limbs instead of spreading out sidewise. The rate of growth thus appears to be modified according as the light is or is not able to penetrate the depth of the wood, and, as carbonic acid is in a corresponding degree more or less rapidly formed from the decomposition of the substances composing the humus. M. Gourmand concludes from these observations that light, when it reaches the ground after passing through foliage, stimulates the production of carbonic acid in decompositions that engender humus in proportion as that gas is decomposed by the green parts; that the growth of the larger trees is retarded, although their green parts stand out in full air and light, where the lower thicket cuts the light off too much from the soil and diminishes its reflex action on their tops; that this effect is governed largely by the arrangement of the limbs of the undergrowth, as it is less marked in glades, where they take a vertical direction; and that the humus under too dense an undergrowth loses a part of its efficiency, and presents an analogy with barn-yard manure, which will remain inert for several years if it is buried too deeply.

The Weather, and Summer Diarrhœas.—Mr. G. B. Longstaff has recently pointed out, in an address before the Society of Medical Officers of Health, some facts concerning the prevalence of summer diarrhœa in England, which are not fully accounted for by the prevailing theories of its origin. He distinguishes between two kinds of diarrhœa: one general, prevailing throughout the year, affecting persons at all ages, and nearly evenly distributed in town and country; and a specific form, which prevails in the summer months and affects most persons at the extremes of life, particularly infants of less than two years old, and which is not definitely modified by changes of season. The second form is, as a rule, a disease of towns, but different towns are differently affected by it. The summer of 1880 was a warm one in England, with the mean temperature in August and September above the average, and a high rainfall in July and September, while little rain fell in August; the death-rate from diarrhœa in England and Wales exceeded the average of the previous ten years by nearly fifty per cent. The comparison of the mortality from this cause in different towns, as between the towns and with the general mortality of the kingdom, failed to establish

such a connection between the changes of temperature and hygrometric conditions and the prevalence of the disease as would be required under the theory that high temperature and drought are primary causes of its production. Out of eleven towns in which the meteorological conditions were recorded, mean temperatures of 60° and upward occurred in June in seven, but in no case was the heat at that time accompanied or immediately followed by numerous deaths from diarrhœa. In nine out of the eleven towns, the highest mean temperature was registered in the first week in September. The epidemic had reached its highest point before that week in four of them. The hot weather continued much longer in London than in Nottingham, yet Nottingham suffered sixty per cent. more severely from diarrhœa than London. The death-rate in Brighton during the last week in July was double that of any other great town for the same week; and "it is a remarkable fact that, although August was hotter and more free from rain than July in London and Brighton, in both towns deaths from diarrhœa diminished in frequency as the month approached its end." Thus, neither the incidence of the disease from week to week nor its distribution in different parts of the country can be explained by meteorological conditions alone; and it is evident that other factors must be taken into account. The events of 1880 as reviewed by him are regarded by Mr. Longstaff as confirmatory, so far as they go, of the theory that the exciting cause of diarrhœa is an organism or some other concomitant of the decomposition of organic matter, which can only exist, or become virulent in its properties, after prolonged high temperature. The fact that lassitude and exhaustion are produced as predisposing conditions to the disease by high temperatures in the early part of the summer does not contradict this theory, but agrees with it fully.

Papuan Women and Feasts.—The *taboo* is in full force in New Guinea, particularly in the restrictions which it imposes on the action of women. They are forbidden to enter the *buambramra*, are excluded from all the feasts, and every dainty which they prepare for the feasts, especially the *keu*, or principal drink, is forbidden to them and to the children. They must not go near the meeting-place of the men, and must instantly flee whenever they hear the sound of music. The only answer given for this exclusion is that, if it were not enforced, the women and children would fall ill and die. The musical instruments of the Papuans are pipes or horns of bamboo, cocoa-nut-shell, or a peculiar root, which are used to reënforce the voice, a kind of a rattle, and a rude drum. Their feasts are prepared with considerable ceremony, but without noise or confusion, and in a way that shows a remarkable appreciation of the division of labor. Important constituents of the feast are the two favorite drinks, the *munki-la*, which is prepared from the cocoa-nut, and the *keu*, an extract from the chewed leaves of a plant of the genus *Piper*. The musical instruments are played during the whole feast, as an infallible means of keeping the women and children from disturbing the guests. After all is over, the lower jaw of the pig or dog which has constituted the principal dish is hung up in the *buambramra* as a memento. The *keu* has soporific qualities, and the friends of a Papuan who has taken too much of it are accustomed, in order to keep him awake, to tickle with a stalk of grass the cornea and conjunctiva of his eyes till they become full of tears, and he declares that he no longer feels sleepy. This operation is considered a very pleasant one.

Woman as a Sanitary Reformer.—Dr. B. W. Richardson declares that woman can pursue no nobler occupation than that of attending to the care of health and the prevention of disease within the domestic sphere. This is peculiarly a calling of woman, not only because it agrees with her character and tastes, but also because she is at home and in a position to give it constant attention, while the man is abroad and engaged with other business. The training required for the proper performance of this function is really very simple. A woman can master physiology so far as to understand the general construction of the human body; she can make herself acquainted with its nine great systems, can be taught to comprehend the leading facts bearing on

the anatomy and physiology of those systems, and to understand what part food plays in the economy, the relationships and effects of particular foods, and their relative adaptation to different ages and conditions of the body. Woman should also be acquainted with the construction and operation of the heart and the lungs. Were women trained in the knowledge of elementary truths about the visual function and guided by them, they would see that their children did not assume those positions in study that conduce to short-sightedness and curved spines; if they carefully studied the nature and functions of the skin, they would learn to insist upon the necessity of daily purification by the bath. Woman might also, and ought to, learn all that health requires in the construction and maintenance of the house: to maintain economically within it an equable temperature at all seasons; to keep the air free from dust; to know all about and watch all the drain-pipes, and see that they are kept as systematically clean as the china; to distinguish whether the water is wholesome and agreeable with as much facility as she determines whether the looking-glass is clear; to superintend the purification of the water; and to see that sunlight finds its way into every apartment, and that damp has no place in any one of her rooms. She ought to study the nature and uses of foods, so as to be able not only to make the best selections and carry out the best modes of preparation, but even to introduce new and improved modes of cooking. The knowledge of the diagnosis of disease is not necessary for women except in a limited degree, but they ought to know the correct names and characters of common diseases, to be acquainted with the facts relating to the periods of incubation of those diseases, and to have the best methods of preventing disease at their fingers' ends.

Sound-Signals.—Mr. E. Price-Edwards recently delivered before the Society of Arts a valuable lecture on "Signaling by Means of Sound," in which he considered the requisites of a good signal, and discussed the merits of the different signals in use. The essential quality of a good sound signal is that it shall give a strong sound which can be uniformly heard at a definite distance. The range of a sound is determined by the force with which it is uttered, and is modified by certain conditions of the atmosphere. It is also controlled in part by its musical pitch. The most effective sounds are not found among the very highest pitches, as many imagine, any more than among the very low ones, but appear to lie among the intermediate pitches, to which the ear is best adapted. Bells have been long in use to give signals, but their sounds are curiously fluctuating, and it is not probable that the vibrations from the largest bell are of sufficient intensity to yield a sound capable of overcoming opposing influences, even of a slight nature. Gongs give a distinctive sound, serviceable at a short distance, but it, too, is soon dissipated after leaving the vicinity of the instrument. Gun-signals are of great value, but, according to Professor Tyndall, they can not always be depended upon to overcome local or temporary obstacles to the propagation of sound. It is, moreover, not always convenient to place and manage guns where it is desirable to use them, or to fire them as rapidly as repetition of sound is wanted. Mr. J. R. Wigham, of Dublin, has invented a gas-gun, which can be loaded and fired at a considerable distance from the point of explosion. It consists of a tube of the desired size placed at the point where the signal is to be made, and connected with a gas-main or gas-holder by iron piping. The gun is loaded with an explosive mixture of gas and atmospheric air, fire is applied at the short end of the tube, and the explosion takes place at the mouth of the gun almost immediately. An exceedingly sudden and sharp blow is given to the air, and a sound-wave of great initial intensity is generated by the explosion of gun-cotton. The apparatus employed to explode that substance in the ordinary way is, however, cumbrous, and can not be used conveniently where speedy manipulation is wanted. A rocket has been devised to carry a charge of gun-cotton, or tonite, to a certain height, where it is caused to explode, which has been tested with the most satisfactory effects; from the height of six hundred feet, to which the rocket may be adapted, a direct sound is sent downward into places which would be completely hidden from the level at which a

gun could be fired, and which would seldom be reached by the sound of its discharge. A kind of cartridge of tonite has been made, to be sent high up into the air, explode there, and scatter a shower of brilliant stars, and has been adopted for the purpose of making signals on many vessels. Mr. Price-Edwards does not express a high opinion of whistles; but one of Mr. Courtenay's automatic buoy-whistles has been used off the Goodwin Sands with success, and two others are to be placed off the English coast. The palm of superiority in all respects, as a signal, is accorded to the American siren. Among the improvements that have been made in it are one for increasing the suddenness and intensity of the sound, adaptations for use on ships and steamers, and the double siren, in which two notes are produced simultaneously, the power of the instrument is more than doubled, and a characteristic feature is given to the sound.

The Mékarski Air-Engine.—The Mékarski air-engine, which has been employed satisfactorily for several months on the tramways of Nantes, France, is being introduced into England by the Compressed Air-Engines Company. Both engines combined with the car and simple traction-engines are used at Nantes. In the combined cars and engines, ten cylindrical steel reservoirs for the compressed air are placed beneath the floor, seven of which are united into one system, called the "battery," and the remaining three are united into a second system called the "reserve." Both the battery and the reserve are charged at the principal station with air compressed to thirty atmospheres. The cylinders are placed horizontally in front of the driving-wheels, and are five and three eighths inches in diameter, by ten and a quarter inches stroke. In front of the car, and on the driver's platform, is a small reservoir, which is charged with water, for about two thirds of its capacity, at a temperature of 320°. The air, in passing from the battery or from the reserve to the engines, traverses the water in this reservoir, and thus becomes heated before reaching the cylinders. After doing its work in the cylinders, it passes into a box, from which it escapes into the air. Under this arrangement, which is peculiar to the Mékarski engine, a smaller quantity of air is needed, and the danger of ice forming in the exhaust passages of the cylinder is obviated. A regulating valve on the top of the hot-water reservoir serves to keep the air from the reservoirs at a uniform pressure, whatever may be the variations in the demand by the engines. The combined car, when ready for work, weighs six tons. The traction-engines draw two cars each. The charge of air carried is enough for the whole "round trip."

Stone-Age Civilization in New Guinea.—The Papuans of the Maclay coast, New Guinea, afford a fine and instructive specimen of a living race still in the stone age. The implements on which they have expended their artistic skill come under the two categories of fragments of flint, shells, and bones, and chipped stones in the form of axes. The ornaments upon them are classified by Mr. J. C. Galton, in a notice of M. Maclay's observations, into ornaments made solely for a decorative purpose, ornaments and drawings demonstrating the first beginning of the figurative or ideal style of writing, and ornaments, sketches, and carvings, which stand in close relation to the superstitions and dark religious ideas of the Papuans. The salient character of the ornaments is that they are generally rectilinear, and this is because the bamboo and reed, on which ornamentation was first attempted, do not conveniently admit of any other style of drawing. The style thus fixed on wood was readily transferred to other substances on which decoration was attempted. That the want of variety in subjects of decoration does not proceed from lack of inventive power and skill is shown by the fact that as soon as some of the men got improved tools, such as bits of glass bottles, they introduced refinements and variations into their wood ornamentation. The Papuans have been supposed to be destitute of any art of writing, but M. Maclay believes that he has found evidence of the use by them of an ideograph in a very rude form. He observed rude figures painted in different places in various combinations, the purpose of which puzzled him for a long time, till it was revealed at a feast which was held on the occasion of the

launching of some canoes, on which the natives had been working for a long time. One of the party, during the feast, drew a number of figures resembling those M. Maclay had seen, and evidently referring to the work in hand. The two boats were represented as they were, half on land and half in water; then followed representations of men carrying pigs, the "covers" of the feast, M. Maclay's canoe with its flag, and the canoes of the visiting guests. Further evidence has made it tolerably clear that such representations are real ideographs. The carvings on wood, to which a religious bearing is ascribed, seem to show a regular progress toward sculpture, by the transformation of simple decorations into bas-relief, then into *alto rilievo*, and finally into the complete figure.

Plant-Migrations.—An interesting monograph has been published at the University of Giessen, Germany, on the migrations of two plants, the *Puccinea malvacearum*, or mallows fungus, and the *Elodea Canadensis* (*Anacharis Canadensis*, Gray). The former plant was first noticed infesting the mallows-plants of Chili. It was observed in Spain, for the first time in Europe, in 1869, having, it is thought, been introduced in the course of trade. Next it was found in France, infesting some ten species of the mallows family, in 1872, 1873, and 1874; it appeared in England in 1873, and was carried to Holland and Belgium in 1874. It was also found at the Cape of Good Hope and in Australia in 1874. It began to attract attention in Germany and Italy in 1874, and appears now to be diffused all over Europe, as its presence is mentioned in Bohemia and Hungary and at Athens, which appears so far to mark its southeastern point of extension. The *Elodea*, or *Anacharis Canadensis*, was noticed in single localities in Ireland in 1836 and 1842. Toward 1850 it became quite abundant, and in the course of the next ten years found its way to the Botanical Gardens of Utrecht and the swamps in the neighborhood of Ghent. It was growing in several places in France in 1866. It is now found in considerable abundance in the lower Rhine, the Elbe and its branches, the Havel and Spree, and the Oder. It has extended from Corrib, Ireland, on the west, and Grenoble, France, on the south, to Riga, on the northeast. It has been carried by sprouts to all the places where it grows; for only female plants (not a single male plant) are to be found in all Europe.

Efficiency of Present Causes in Geological Action.—M. Stanislas Meunier has recently published a work discussing the sufficiency of the causes which are still in operation to account for the production of the geological phenomena of the past. Illustrations of the principle involved in the discussion may easily be found in examining some of the formations near the surface. In the section of the coal-beds of Valenciennes, thick, horizontal cretaceous beds appear, resting on carboniferous beds, the strata of which are contorted, bent, and folded neither more nor less than the strata of which the highest mountain-chains are composed. As the contact of the chalk and the coal is horizontal, it must be admitted that, previous to the deposit of the secondary rocks, the ground, which had been greatly disturbed by the foldings of the carboniferous strata, had been again planed down to a level. The first thought would be to attribute the planing down to some sudden and violent action carrying away all of the missing matter at once. The view is entirely changed when we remark that quite as important denudations are taking place now in populous districts without any perturbations of a violent character. Thus, on the British coast of the English Channel the sea is gaining about a yard a year upon the land, and the fact is recognized in sales. The result of this denudation, which is taking place so gradually, can not be distinguished from that of a sudden razing of the strata at the bottom of the sea. M. Meunier examines likewise the theory that river-valleys have been formed by the action of streams in a period of floods, when they were many times larger than the present rivers. The valleys of the rivers, he believes, correspond with original fractures of the soil; this once accepted, we may admit that the stream was neither much more voluminous nor much more rapid in quaternary times than at present. In the course of an indeterminate period of time it has widened

its valley by the operation of the sinuosity of its meanderings, and has covered the whole surface of the soil with detritus. The production of gravel terraces may be attributed to slight elevations of the soil; and many supposed bowlders of considerable dimensions may have been formed by the weathering away of angular blocks. The disappearance of species is now regarded as simply the natural result of the competition of other species; and evidence is not wholly wanting that the introduction of new species is still going on. Thus, a little lizard has been observed quartered on a rock near the Island of Capri which is manifestly derived from a quite different lizard living in the island itself.

NOTES.

PROFESSOR FARLOW has, at the request of the United States Fish Commission, investigated the cause of the red color which sometimes appears on dried codfish during hot weather, in connection with which it has been noticed that the fish affected by it decayed with comparative quickness. He has found that the redness is owing to a minute plant, the *Clathrocystis roseo-persicina*, which is known in America and Europe, and may sometimes be found tingeing the surface of damp ground with a purplish hue, and in the macerating-tubs of anatomists. It does not appear to flourish or increase very rapidly at a temperature below 65°. It could have been derived from many sources, but Professor Farlow has traced its origin particularly to the salt with which the fish are cured.

GEORGE B. EMERSON, LL. D., author of the "Report on the Trees and Shrubs growing naturally in the Forests of Massachusetts," died last March, in Boston. He was born in Kennebunk, Maine, in 1797, became known as a teacher, and a writer on educational topics, and has been president of the Boston Society of Natural History.

"NATURE" notices a curious confusion in the different senses in which the term *trawling* is used by British and American fishermen. A trawl in England is a large purse-net attached to a heavy beam raised upon trawl-heads, or irons at either end, and dragged along the bottom of the sea. In Scotland it is simply a drift or seine-net. In America it is a long line baited with hooks, and left on the bottom of the sea. Each of the three modes of fishing is objected to in the different countries in which they are employed by men who use one of the others. In Scotland the drift-net fishermen object to the trawl or seine-nets; in England the drift-net and the line fishermen object to the beam-trawlers; in America the hand-line fishermen object to the set-line fishermen, whom they call "trawlers." The complaints are all due to the jealousy usually felt at the introduction of new machinery in any industry; and the Governments of both countries may safely disregard them, since they are the most effective answers to one another.

THE fifty-first annual meeting of the British Association will be opened at York, on the 31st of August. The address will be delivered by Sir John Lubbock, President-elect. The presidents of the several sections are: A, Sir W. Thomson; B, Professor A. W. Williamson; C, Professor A. C. Ramsay; D, Professor Owen, in the department of Zoölogy; Professor W. H. Flower, in the department of Anthropology; Professor J. S. Burdon-Sanderson, in the department of Anatomy; E, Sir J. D. Hooker; F, the Right Honorable Grant Duff; G, Sir W. G. Armstrong. Evening addresses will be delivered by Professor Huxley and Sir W. Spottiswoode.

THE third meeting of the International Geographical Congress is to be held at Venice, September 15th to 22d. Representatives from all geographical societies are invited to attend, and they will be permitted to speak in any language. The discussions will be held in the eight sections of mathematical geography, geology, and topography; hydrography; physical, geological, meteorological, botanical, and zoölogical geography; anthropological, ethnological, and philological geography; historical geography; economical, commercial, and statistical geography; the study, teaching, and diffusion of geography; explorations and travels. An international geographical exhibition, the schedule of which is very full, and is divided into sections corresponding with those of the Congress, will be held in connection with it, and will be open during September.

EXPERIMENTS were recently made at the Grand Opéra in Paris in the transmission through the microphone of the musical part of the representation, with results that are described as marvelous. The modulations of the voice and the concerted pieces were distinctly heard and distinguished, to the admiration of the distant audience. A demonstration of this character is expected to form a regular feature at the coming Electrical Exposition, where a special hall will be provided, whence visitors will be able to enjoy the representations at the Opera-House without leaving the place. "La Nature" foresees the day when music will be sent

around by the wires to assembly-rooms, and we will be able to "turn it on" by adjusting a commutator, as we now get water by turning a faucet.

UNDER the head of "Birds out of Place," Mr. Charles Aldrich, of Webster City, Iowa, records, in "The American Naturalist," that a robin remained last winter on his farm, frequenting a sheltered spot where a little spring of water flowed out of a bank below a mill-dam. He also tells of some crows that were found, during the severe weather, roosting with the chickens, which, for the want of a better shelter, were accustomed to roost in the low branches of a thicket near the house of one of his neighbors. A comparison of many similar observations to those of the robin, which might be recorded if those who made them would take the pains, would probably show that many so-called birds of passage elect to spend the winter in their northern homes, when suitable shelter from violent storms and cold is provided for them, and a supply of food is made accessible.

A FIELD CLUB, composed of specialists in various branches of science, and working naturalists, has lately been organized at Des Moines, Iowa. It will publish any results reached which may prove of sufficient value, in the form of occasional bulletins, and proposes, ultimately, to work up the natural history of the entire State, in which little has been done except by individuals, in the shape of local contributions made at their own expense. Geological surveys have been instituted twice, to be abruptly closed by the Legislature before anything of moment could be accomplished. A society like this one can do much to promote a better knowledge of the State, and to awaken a spirit of thorough investigation.

M. DR. LEMOINE has discovered in the lower tertiary beds near Rheims—which were considered nearly if not quite Azoic—fossil remains of an extremely interesting fauna, comprising numerous new species, and even some new genera, of mammals, birds, and reptiles. Many of these species exhibit characters intermediate between those of types which have been heretofore described.

M. G. TROUVÉ has applied two of his electric motors to an English tricycle, with a gratifying success in making it go. The machines were each fed by three of the accumulators which he uses in his polyscope. The tricycle ran for an hour and a half at the speed of a good carriage. M. Trouvé intends to construct another motor, with which he expects to attain a speed of twelve or sixteen miles an hour.

THE Appalachian Mountain Club is enjoying an encouraging prosperity. Eighty-five members were added to its list last year, making the whole present number three hundred and twenty. Its position in the community is regarded as established and recognized, and its sphere of usefulness and plans of work as having become in great part well defined and settled. Its library is increasing considerably, by the exchange of its publications for those of other similar societies, which has been undertaken with forty-one societies in Europe, as well as with American organizations. Nine regular meetings were held during 1880, and field meetings at Plymouth and the Fabyan House, New Hampshire, and several excursions were made. The last number of its journal, "Appalachia," contains, besides the reports, the annual address of President Charles R. Cross on "Barometric Measurement of Heights"; and papers on "Mount Cardigan," by Harold Murdock, and "A Sojourn in Andover, Maine," by Gaetano Lanza.

ON the 5th of March last, the main seam of coal in the Ashton Moss Colliery, in Lancashire, England, was cut at the depth of 2,691 feet, or 231 feet lower than the deepest sinking heretofore worked in England. The temperature in the colliery, at the depth of 860 yards, was 78°.

M. DE QUATREFAGES reports that fossil remains of men, well preserved, have been discovered in the quaternary limestones of Nice. M. Desor has determined their geological age, which, it is said, can not be contested; and M. de Quatrefages has determined the race to which they belong as that which has been long known as the Cromagnon race.

SOME experiments described by Mr. A. Vogt, in the "Zeitschrift für Biologie," indicate that the southern walls of houses absorb less heat from solar radiation during the day than the eastern and western walls, notwithstanding they are exposed for a considerable longer time to the direct rays of the sun. On a day when the highest temperature of the air was observed at four o'clock in the afternoon, and the maximum of solar radiation at one o'clock, the thermometer behind the eastern wall was highest at eleven o'clock in the morning, behind the southern wall at three, and behind the western at six o'clock in the afternoon.

THE Central Meteorological Bureau of France is in telegraphic communication with one hundred and twenty stations in Europe and Northern Africa, over a territory extending from Bodo, in northern Norway, to Laghore, in southern Algeria, and from the island of Madeira to Moscow.

ROBERT WILHELM BUNSEN.